SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JUNE 1909.

GENERAL PHYSICS.

962. *Camera for Recording Scale-readings.* **J. R. Milne.** (Roy. Soc. Edinburgh, Proc. 29. pp. 176–181, 1908–1909.)—Describes a camera designed to take a series of photographs of the scale and vernier of a polarimeter or other instrument, which, on subsequent examination, will show the relative position of the scale and vernier at the time of each exposure. The camera is focussed on the scale and vernier, which must be made so that the scale moves, the vernier remaining stationary, and the scale is illuminated in any convenient manner. A simple mechanism is used to make the exposure and to cause the plate to move on to a new position after the exposure is made. In this way 60 photographs, in rows of 10 each, can be obtained on a 5 × 4 in. plate. In order to identify individual photographs, or to indicate the commencement of a new series of records, a means is provided whereby a single or a double wedge-shaped mark can be produced on the photographs, and, to save counting, a bell rings at each tenth exposure. The advantages claimed for this method of making photographic records of the readings of an instrument are: (1) The saving of labour and strain to the eye of the observer, which is left in a better condition for its principal work. (2) The elimination of the possibility of errors of reading on the part of the observer. (3) The great saving of time which is effected. (4) The elimination of all personal bias due to a knowledge of the results that are being obtained. (5) The securing of a permanent record of the readings. A. W.

963. *Analytical Machine.* **P. E. Ludgate.** (Roy. Dublin Soc., Proc. 12. 9. pp. 77–91, April, 1909.)—The author here gives a short account of the result of six years' work undertaken with the object of designing machinery capable of performing calculations, however intricate or laborious, without the immediate guidance of the human intellect. In some respects the proposed machine resembles Babbage's analytical engine, but in others differs considerably, for while Babbage designed two sets of Jacquard-cards, one set to govern the operations and the other set to select the numbers to be operated on, the author uses one sheet or roll of perforated paper to perform both these functions in the order and manner necessary to solve the formula

to which the particular paper is assigned. Each row of perforations across the formula-paper directs the machine in some definite step of calculation—such as, for instance, a complete multiplication, including the selection of the numbers to be multiplied together. The machine prints all results, and, if required, the data, and any noteworthy values which transpire during the calculation. The mechanical details are too complex to deal with briefly.
A. W.

964. *Testing-machine for Combined Bending and Torsion.* **E. G. Coker.** (Phil. Mag. 17. pp. 496–502, April, 1909. Paper read before the Physical Soc., Feb. 26, 1909.)—The specimen bar is suspended at two points which it overhangs equally at each end. Equal weights hang at the ends, so that there is a uniform bending moment between the points of suspension. The rod is also twisted by two equal weights hanging from two equal levers, one standing out from each side, placed at the points of suspension. (In the machine one of these levers is replaced by a worm and worm-wheel torsion head mounted in trunnions.) An instrument is also described which can be used to measure either the elastic torsion or elastic bending strain. It consists in principle of a reading microscope attached to one end of the length under observation, by means of which the movements of a wire carried by the other end can be measured.
F. R.

965. *Recent Experiments on Elasticity.* **G. Ercolini.** (N. Cimento, 17. pp. 85–94, Jan.–Feb., 1909.)—The paper is a review of recent work on elasticity, in particular that of Cantone for small deformations and of Bouasse [see Abstract No. 1225 (1908)] for large deformations. Extension, flexure, and torsional strain are all considered, and the results are extremely complex. Amongst other conclusions it is pointed out that the damping of vibrations is due to the dissipation of energy corresponding to the hysteresis effect on taking the specimen through a cycle of strain, and not to "molecular friction." Also it is pointed out that the metals are only rendered isotropic to a very approximate extent by annealing.
S. G. S.

966. *Shear Strength and Elasticity.* **M. Grübler.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 449–455, March 20, 1909.)—Shear stress was applied to short hollow cylinders of 1 : 3 cement mortar mounted upon a shaft and surrounded by a clamp to which levers were attached. The shear stress would thus be uniform at all points at the same distance from the axis. The modulus of elasticity in shear, G, rapidly fell with increasing load to about 2,000 atmos. Failure did not occur in shear in any case, although a max. shear stress, S, of 39·56 atmos. was applied, so that the shear strength must be higher than this figure. Failure occurred by tension in each test. From former experiments [see Abstract No. 578 (1907)] it is known that Young's modulus E is at least 60,000 atmos. and the tensile strength T less than 27 atmos., so that in both respects this material disagrees with the elastic theory of isotropic materials which requires $G > \frac{1}{3} E$ and $S < T$.
F. R.

967. *Test of Large Pipe.* (Eng. News, 61. p. 420, April 15, 1909.)—Describes the test of a 42-in. diam. pipe, about 20 ft. long, $\frac{7}{16}$ in. thick, in connection with the contract for the 12-mile main of Springfield waterworks. The max. head in service would be about 150 lbs. per sq. in. The test was abandoned at 1,050 lbs. per sq. in., the stress then being about 50,400 lbs. per sq. in. The circumference had then increased by about 4 in., and the "lock-bar" joints had not failed. The ultimate strength of test-strips after the pressure test was 57,500 lbs. per sq. in., elastic limit 31,000 lbs. per sq. in., elongation 21 per cent. on 8 in.; fracture did not occur at the lock-bar. There are two longitudinal lock-bar joints, 180° apart. In this size and thickness of pipe the lock-bar is 2¼ in. wide and 2¼ in. thick, rebated on each edge leaving a web of $\frac{7}{16}$ in. The edges of the plates are upset cold to about $\frac{11}{16}$ in. thick to enter the rebates. The joints between lengths are simple tapers of 4 in. lap, single riveted, and the lock-bar is scarfed down in the lap. F. R.

968. *Bursting Strength of Glass Tubing.* **J. R. Roebuck.** (Phys. Rev. 28. pp. 264–276, April, 1909.)—The results of tests of German soda glass tubing from 1 to 7 mm. bore and 1 to 4 mm. wall are given. Average bursting pressures in atmos. are shown in the following table:—

Bore, mm.	1	2	3	4	5	6	7
Wall, mm.							
1	—	311	280	280	220	151	104
2	570	—	341	—	327	235	215
3	555	423	456	404	—	—	231
4	—	453	—	401	305	321	280

The hoop tension at the inner surface derived by Clavarino's formula is $T = (2 + 5r^2)p/4(r^2 - 1)$, where r is ratio of external to internal radius and p the internal pressure. T is not found to vary systematically with bore and wall, but values from 415 to 990 atmos. were found, average 619, or 6·39 kg. per mm.². The formula is regarded as satisfactory for use within the range of the tests. For values of r greater than about 4, $T = 1{\cdot}3p$. Thus there is no gain in reducing the bore of an ordinary capillary below 1 mm. None of the ordinarily used tubes can, on the other hand, be taken as thin-walled. As factor of safety 2 should usually be employed. Most of the tubing tested was found to be in a state of considerable stress, but was annealed in order to get best results. A method of making glass-metal joints is described which was found to be very satisfactory. F. R.

969. *Tensile Strength of Iron in the Magnetic Field.* **E. Drago.** (Accad. Lincei, Atti, 18. pp. 111–116, Feb. 7, and pp. 294–300, March 21, 1909.)—The author has determined the breaking strength of iron wires when suspended inside a vertical solenoid, or in the field of a Faraday electromagnet, a long series of experiments being made to ascertain the correction necessary for variation in temperature. Full results are given of experiments with iron wires from three different sources, having diameters of 0·3–0·4 mm., the magnetic field ranging from 40 to 1,400 gauss. In all cases the breaking weight is greater in the magnetic field, the mean increase being 0·09 per cent. W. H. Si.

970. *Resistance of Materials to Impact.* **T. E. Stanton** and **L. Bairstow.** (Inst. Mech. Engin., Proc. 4. pp. 889–919; Discussion and Communications, pp. 974–1022, Oct.-Dec., 1908. Communication from the National Physical Laboratory. Abstracts in Engineering, 86. pp. 781–786; Discussion, pp. 714, 716, 717, Nov. 27, and 772, Dec. 4, 1908. Engineer, 106. pp. 575–577, Nov. 27,

1908.)—Results given by a series of steels under the following tests are recorded: (*a*) Single-blow bending, notched test-pieces, by the Izod machine [see Abstract No. 2254B (1904)]; (*b*) similar test-pieces statically bent; (*c*) single-blow direct tension, unnotched test-pieces, by a new machine; (*d*) ordinary tensile tests; (*e*) alternate shock bending, notched test-pieces, by machine described in Abstract No. 1520 (1906); (*f*) alternate tension and compression shock, unnotched test-pieces, by a new machine. Chemical compositions of the steels tested are given; these include several low-carbon steels and iron, and a series of Swedish Bessemer steels with carbon from 0·17 to 0·645 per cent. A marked similarity is found between results under (*a*) and (*b*), and between those under (*c*) and (*d*); the authors infer that a careful static test will show any source of weakness which a single-blow shock test can reveal. It was found that duplicate tests under method (*e*) agreed nearly always with the mean curve relating energy of blow and number of blows to fracture within 8 per cent., thus showing the steel to be highly homogeneous. Results with high striking energy, and hence few blows, in tests (*e*) resembled those under (*a*); but with low striking energy in (*e*) the curve relating energy of blow, and carbon content, had practically the opposite characteristics to the curve for tests (*a*). The limiting resistance in tests (*e*) was not reached in 1,000,000 blows, as test-pieces which had withstood this were found upon sectioning to be incipiently cracked. The depths of crack for a constant high number of blows of low energy was plotted against energy and the limiting resistance deduced by extrapolation. The proof resiliencies ($\frac{1}{2}f^2/E$), of a wrought iron, and steels of 0·2, 0·4, 0·6 per cent. carbon were respectively in the ratios 1 : 0·92 : 2·5 : 2·7. The limiting values of the energy of blow obtained as above were as 1 : 0·92 : 1·3 : 1·5. f is the real elastic limit, *i.e.*, ½ the limiting range of stress of the material as found in direct alternating-stress tests [see Abstract No. 878 (1907)]. The tests under (*f*) gave results of very similar form to those obtained in direct alternating-stress tests just referred to. The microscopic appearance of the cracks developed in tests under (*f*) is described. With a given fall of tup in tests (*e*) the number of blows for fracture was independent of sharpness of notch when the number of blows was large, depended on ratio of diam. at bottom of notch to diam. of specimen, and depended on the span. Cold-worked mild steel had a higher curve of energy of blow under tests (*e*) than the same material not cold worked, but absorbed less energy in (*a*). The curve for a faulty boiler-plate was low in both (*e*) and (*a*) tests. The authors point out that for the detection of brittleness the one-blow method is best, and for the detection of low elastic resistance the many-blow method is best, notched bending tests being most convenient in both cases. The manner in which the tests may be used to determine the characteristics of a material is exemplified in the case of two Cu-Al alloys. [For *Discussion*, see next Abstract.] F. R.

971. *Methods of Impact Testing.* **F. W. Harbord.** (Inst. Mech. Engin., Proc. 4. pp. 921–974; Discussion and Communications, pp. 974–1022, Oct.–Dec., 1908. Abstracts in Engineering, 86. pp. 786–788; Discussion, pp. 714, 716, and 717, Nov. 27, and pp. 768–771; Discussion, p. 772, Dec, 4, 1908. Engineer, 106. pp. 602–603, Dec. 4, 1908.)—Gives detailed results obtained in numerous duplicate tests of over 40 steels by the following methods of shock testing: (1) Seaton and Jude, one notch in centre of bar, two supports, many blows [see Abstract No. 1639B (1905)]; (2) Frémont, one notch in centre, two supports, one blow [see Abstract No. 695 (1905)]; (3) Izod, one notch, test-

piece clamped at one end, one blow at the other end [see Abstract No. 2254B (1904)]; (4) Kirkaldy, two opposite notches, test-piece clamped at one end, series of alternate blows at the other end. Tensile test results and chemical analyses are given, and also in some cases tests by Arnold's method [Abstract No. 2795B (1904)] and by Sankey's method [Abstract No. 268 (1906)]. Typical ranges of variation expressed as percentages of the mean are given in the following table:—

Condition of Steel.	As Rolled.			Overheated.			Restored.		
Carbon per cent.	0·26	0·32	0·41	0·26	0·32	0·41	0·26	0·34	0·41
Method:									
Seaton and Jude	15	35	48	69	55	50	60	48	95
Frémont	25	20	38	30	14	16	22	78	109
Izod	7	49	64	35	9	31	21	19	84
Kirkaldy (horizontal)	30	18	8	29	59	60	26	29	29
Kirkaldy (vertical)	2	14	5	27	20	47	86	36	49

The "overheated" bars were heated in a box to 1,280° C. for 1 hour, and cooled in the air. The "restored" bars were similarly heated, slowly cooled to 600°, heated to 870° and cooled slowly. The author's general conclusion from the results is that although it is to some extent unfair to condemn impact tests when they do not agree with tensile tests, yet the variation of results with any one method was so great, and so different from that with another that he had serious doubts as to the value of the tests. In the *discussion*, **A. Jude** said that the disagreement between duplicate tests was not due to fault of the method of test, but to the fact that the specimens were not structural duplicates, despite identical treatment. He correlated, with micrographs and figures, shock test results, grain size, and degree of roughness of the sides of broken tensile pieces. **B. Blount** described a tensile impact machine, and gave a photograph and results of tests made with the machine. **M. Longridge** gave a number of test results in which brittleness was consistently indicated, when it existed, by shock test. **P. Breuil** gave results which in part confirmed some of Stanton's and Bairstow's, and, in regard to discordance of duplicates, Harbord's results. [See also Abstract No. 1585B (1904).] F. R.

972. *Determination of Rate of Clock by means of Zenith Sector.* **A. Alessio.** (Accad. Lincei, Atti, 18. pp. 275–280, March 21, 1909.)—A method of determining the rate of a clock is described which bears a resemblance to the finding of latitude by two meridian observations of a star. A star is chosen as it crosses the prime vertical (say E) and the time taken for several equal increases in altitude (30″) observed, and a second set of observations for similar decreases of altitude of another star (W) are also taken. On the next, or any succeeding day, similar observations of the same two stars are made, and from these four sets the rate of the clock is found. The second part of the paper is given to a discussion of the errors. S. G. S.

973. *Central Forces.* **G. Zappa.** (Accad. Lincei, Atti, 18. pp. 280–285, March 21, 1909.)—F. L. Griffin has shown that for a given elliptical orbit an infinite number of laws of force other than Newton's are possible. The author in the present note shows that for each law the number of elliptical orbits of the same eccentricity and having the major axis in the same line is infinite, and discusses these ellipses. S. G. S.

974. *Surface Separation from Solutions of Saponin, Peptone, and Albumin.* **S. A. Shorter.** (Phil. Mag. 17. pp. 560–572, April, 1909.)—The surface-layers of many solutions contain the dissolved substance in a degree of concentration much higher than that in the body of the liquid. In some cases the mechanical properties of this layer indicate the separation of matter in the solid state. The results of ageing the solutions and testing their surface elasticities point to the interpretations (1) that the stationary values of surface elasticity correspond to uniform layers a definite number of molecules thick, thus the value 702 corresponds to a surface pellicle 15 molecules thick; (2) that a partially formed molecular layer does not appreciably increase the surface elasticity till nearly complete [see Abstract No. 2102 (1904)]. E. H. B.

975. *Molecular Flow of Gases through Apertures and Effusion.* **M. Knudsen.** (Ann. d. Physik, 28. 5. pp. 999–1016, March 30, 1909. Copenhagen Univ., Jan., 1909.)—The author has shown [see Abstract No. 871 (1909)] that when a gas flows through a tube the dimensions of which are vanishingly small in comparison with the mean free path of the molecules, the mass of gas flowing through per sec. under a pressure-difference $(p'-p'')$ is given by $Q=(1/\sqrt{\rho_1})(p'-p'')/W$, where ρ_1 is the density of the gas at 1 dyne/cm.^{2} and W is a quantity depending on the dimensions of the tube and may be regarded as a resistance. Starting out from a fundamental result in the kinetic theory of gases he obtains the equation $Q=\frac{A}{\sqrt{2\pi}}\cdot\frac{1}{\sqrt{\rho_1}}(p'-p'')$ for the flow of gas through an orifice of area A the dimensions of which are vanishingly small in comparison with the mean free path. Combining these two results we get the equation $Q=(1/\sqrt{\rho_1})(p'-p'')/(W+W_1)$ for the flow through a tube having in it a plate with an opening, where $W_1=\sqrt{2\pi}/A$. For the experimental verification of these results the author makes use of the apparatus which he used for his previous work. Observations are made on the flow of hydrogen, oxygen and CO_2 through a fine pin-hole made in a thin plate of Pt which is fixed into a glass tube (11 mm. wide). The experiments show that the formula for the molecular flow through an aperture holds with great accuracy and that no deviation can be detected even if the mean free path is decreased to ten times the width of the opening. If the mean free path becomes smaller, the quantity of gas flowing through increases for the given pressure-difference; this increase is more marked the smaller the pressure-difference in comparison with the mean pressure. W. C. S. P.

976. *Viscosity of Water.* **R. Hosking.** (Phil. Mag. 17. pp. 502–520, April, 1909. Paper read before the Royal Soc. of New South Wales, June 3, 1908.)—In connection with the reduction formula for the velocity of water by the efflux method $\eta=\pi R^4 g\rho hT/8VL(1+nR/L)-mV\delta(1+2kl)/8\pi TL(1+nR/L)$ the author made determinations of the constants m and n at velocities which made the second term a large proportion of the viscosity. The values of m for each end of each of four capillaries were greater in every case than 1·12 the theoretical value, and were: 1·180, 1·164, 1·164, 1·162, 1·128, 1·186, 1·166, 1·216. At 0°, 25°, and 50° C., the values of n were in each case zero. The absolute values of the viscosity of water at 0°, 25°, 50° are 0·01798, 0·00893, 0·00550, which are probably correct to 0·1 per cent. At 50° constant values of the viscosity were obtained in cases where the kinetic energy correction was as high as 60 per cent. of the viscosity. m had constant values over a big range of pressure, but at high pressures m, or the nature of flow, changed abruptly. The velocities were then much below the critical velocities but above the lower limit of critical velocity. F. R.

977. *Propulsion of Ships and Hydroplanes.* **E. E. Marchand-Bey.** (Bull. Technologique, No. 8. pp. 800–882, March, 1909.)—The author first gives the theory of his "rational screw propeller," and in succeeding sections deals with the following points: Theory of action of the propeller blades in water; The mechanical work involved; Application of the author's "rational" screw to the liner *la Lorraine*; General questions in propulsion; Theory of hydroplanes in still water and calm air. The author would like to call attention to his results, which indicate that such a screw will give a 12 per cent. greater efficiency than screws of other known types, and states that it is possible, by using such a screw, to actually obtain a global efficiency of 80 per cent. L. H. W.

978. *Motion of a Disc in a Fluid.* **A. de Gramont de Guiche.** (Comptes Rendus, 148. pp. 1157–1160, May 3, 1909.)—The resistance of fluids has usually been determined by giving some defined movement to a body in the fluid, or by sending the fluid through a tube. The author of the present paper has essayed a study of the laws of aerodynamics by projecting, in a calm medium, bodies quite free from restraint, and registering their trajectories. A comparison of the actual trajectory with the trajectory which would be obtained in a vacuum allows the action of the medium to be determined. An apparatus was used with which discs could be projected in an arbitrary direction; and the velocity of the centre of gravity of the disc could be varied, as also could the velocity of rotation about an axis perpendicular to the plane of departure. Any particular experiment could be repeated as often as desired. On account of their rotation the discs remained perfectly horizontal during their fall. Moreover, as they were very thin, and the duration of an experiment did not exceed 1 or 2 sec., the horizontal component of the velocity remained sensibly constant. If P_{90} is the pressure of the air on a plane moving through the air in a direction normal to the plane, and P_α the normal pressure produced under the same conditions and with the same velocity of the centre of gravity, when the direction of motion makes an angle α with the plane, the ratio P_α/P_{90}, which is evidently a function of α, has been represented by different formulæ. Old writers give (i) $P_\alpha/P_{90} = \sin^2\alpha$, supposing the pressure to be the same as if α were 90°, but the velocity reduced to its normal component. Other formulæ given more recently are (ii) $P_\alpha/P_{90} = \sin\alpha$, $P_\alpha/P_{90} = \alpha/90$ (Eiffel), while Duchemin has proposed the formula (iii) $P_\alpha/P_{90} = 2\sin\alpha/(1 + \sin^2\alpha)$, which gives results in accord with Langley's experimental results for values of α greater than 15°. These formulæ give results which do not differ much if α is near 90°, but they differ a great deal for small angles, which are the most interesting. The author's apparatus allows observations to be made with small values of α. The trajectory described by the centre of gravity of the disc is composed of a curve, situated sensibly in a vertical plane (the rotation causing a slight deviation), at first parabolic in form, but quickly becoming rectilinear, when the velocity of the centre of gravity is uniform, and, as the disc remains horizontal, the angle α is constant. Hence, if p is the weight of the disc, V the velocity of its centre of gravity and S the area, formulæ (i) (ii) and (iii) give $p = K_1SV^2 \sin^2 \alpha$, $p = K_2SV^2 \sin \alpha$, $p = K_3SV^2\, 2 \sin \alpha/(1 + \sin^2 \alpha)$, K_1, K_2, K_3 being constants which, if the formulæ are correct, should have the same value as obtained when $\alpha = 90°$. The results of experiments show that Duchemin's formula is the only one which gives values of K comparable with those found previously by other experimenters. The author will study next the effect of the rotation on the magnitude of the air pressure, and employ a chronophotographic method of measurement. A. W.

979. *Note on Tidal Bores.* **Rayleigh.** (Roy. Soc., Proc. Ser. A. 81. pp. 448–449, Dec. 22, 1908.)—In order to determine the energy loss at a bore we may suppose it is reduced to rest by superposing an equal and opposite motion on the whole water system. The problem being taken as in two dimensions, it follows that the loss of energy per unit time at the bore is $lug\,(l' - l)\,[(l^2 + l'^2)/4ll']$, where l, l', u, u' are the respective depths and velocities of the stream on two sides of the bore and at such distances from it that the motions there are sensibly uniform. The impossibility of a gain of energy shows that the motions here contemplated cannot be reversed.

W. C. S. P.

980. *Elastic Solid Æther.* **A. McAulay.** (Phil. Mag. 17. pp. 558–560, April, 1909. Paper read before the Australasian Assoc. for the Advancement of Science, Brisbane, Jan., 1909.)—A mathematical discussion of an æther with two moduli and satisfying MacCullagh's crystalline optical conditions. Three states of the medium are considered: (1) the zero state (not one of equilibrium); (2) the intrinsically strained state, which is one of stable equilibrium; (3) the actual disturbed state (this is a state obtained from state (2) by displacements small compared with those by which (2) was produced from the zero state). An elastic solid of density 10^6 gm./cm.^{3} is supposed to fill space. Its potential energy per unit volume is considered to consist of two terms—a cubic rotational term and a hydrostatic quadratic term. The cubic rotational term is $-efg \times 1{\cdot}8 \times 10^{38}$ ergs/cm.^{3}, where e, f, g are the small fractions expressing the principal elongations necessary to pass from the zero to the actual state. It is shown that (approximately) the cubic rotational stress is zero when the curl is zero, so that there is from the cubic term no elastic resistance to irrotational strain. The medium is then irrotationally intrinsically strained from the zero state by elongations $e_0 = f_0 = g_0 = 10^{-11}$, this state being called free æther. But, throughout certain volumes called crystals, the elongations e_0, &c., change to e_1, f_1, g_1, which are each less than e_0 in the ratios of the squares of the corresponding velocities of light to the square of that in free æther. Due to the difference of the intrinsic strain throughout the crystalline volumes and throughout the remaining free æther there will be a misfit throughout their interface regions. The hydrostatic quadratic term is zero in state (2) and, reckoned from this state, is in the actual state $b\,(e_3 + f_3 + g_3)^2$, where b is a positive constant, and e_3, f_3, and g_3 are elongations. To obtain a light-intensity, as great as at the sun's surface, 2 ergs/cm.^{3}, the max. disturbed curl $< 10^{-18}$.

The author then discusses the behaviour of this medium by vector analysis and points out how the theory differs from those of MacCullagh, of Green, and of Maxwell. He also shows that in the present theory we are not confronted with the appearance of a wave of condensation when a wave of curl suffers reflection. It is believed that the theory here given reconciles Green and MacCullagh, and provides what has been so persistently sought—an easily conceived dynamical explanation of MacCullagh's foundation. Taken in connection with some such elaborate superstructure as Larmor's "Æther and Matter," it is further thought that this theory furnishes the fundamental dynamical explanation of modern electromagnetic theory. E. H. B.

981. *On Ætherial Stress and Momentum.* **C. V. Burton.** (Phil. Mag. 17. pp. 641–654, April, 1909.)—The author suggests that neither the electric nor the magnetic vector corresponds to a bodily flow of æther. Their vector product also cannot correspond to a flow of æther. He concludes, therefore, that no purely electromagnetic phenomenon involves the bodily displacement of any æther element. The æther remains in the grosser sense permanently at rest and experiences only changes of "polarisation." But if ætherial waves of bodily transverse displacement have no part in elecromagnetic or in gravitational phenomena, it is natural to ask whether it is incapable of transmitting waves of that type. The author suggests that ætherial waves of bodily transverse displacement could not possibly be initiated by any manipulation of ordinary matter. A. R.

982. *Pendulum Observations in India.* **G. P. Lenox-Conyngham.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 888–892, March, 1909.)—The new pendulum operations for the determination of gravity in India were commenced in 1904, with four half-seconds' pendulums of the v. Sterneck pattern. In the discussion particular attention is devoted to the comparison of the results with the conclusion advocated by Burrard as to the existence of a chain of excessive density running parallel to the Himalayas across the Indian peninsula. This view appears to be supported by the recent results. C. P. B.

983. *The Psychrometer.* **N. Ekholm.** (Ark. för Mat. Astron. och Fysik, Stockholm, 4. 15. pp. 1–36, 1908.)—The mounting of the wet bulb thermometer is found to be hygroscopic, a fact which should be taken into account in the calculation of vapour pressure from readings of dry and wet bulb thermometers by introducing a constant η into Regnault's well-known formula, thus $x = \eta f' - AB(t - t')$. The author finds the following values for η for different materials: linen 0·9787, silk 0·940, wool 0·921, cotton 0·918. The first part of the paper is devoted to a recalculation of Regnault's results, published in his classic paper, "Etudes sur l'hygrométrie" (Annal. Chim. Phys., ser. 3, vol. 37, 1853) according to the formula given above, the values of η and A being determined by the method of least squares. He finds that the difference between Regnault's observed values and the values calculated from the formula is diminished by using the amended formula. From experiments by Svensson (Meteorolog. Zeitschr. p. 201, 1896), Ekholm finds the values $\eta = 0·9737$, $A = 0·000596$ or $0·000526$, according as the wet bulb is covered by water or by ice, for use with Assmann's ventilated psychrometer, in which the wet bulb is covered by thin linen. If the wet bulb is covered with ice, the value of the vapour pressure of ice, at temperature t', must be substituted for f'. The second part of the paper is devoted to the consideration of the amount by which the reading of the wet bulb must be lowered, on account of the hygroscopic nature of its covering, in order that satisfactory values for vapour pressure and humidity may be obtained from the Wild-Jelinek tables, with unventilated thermometers. The paper

ends with tables giving the saturation pressure of water-vapour for each degree from −65° C. to +105° C. and of ice-vapour from −65° C. to 0° C., recalculated from all available data. R. G. K. L.

984. *Upper Air Research in Central Africa.* **A. Berson.** (Nature, 80. pp. 171–172, April 8, 1909.)—A series of ascents of kites and balloons on Lake Victoria was organised by the Prussian Aeronautical Observatory of Lindenberg in July last. A registering balloon, which attained the height of 19·8 km. recorded, at that altitude, a temperature of −84° C.—a lower value than has ever been found at equal or even greater altitudes over Europe. The "isothermal layer" was entered on several occasions. On several occasions also an uppermost current from the west was found above the regular easterly current of the equatorial region. R. G. K. L.

985. *Upper Air Research in the Trade Winds.* **L. Teisserenc de Bort** and **A. L. Rotch.** (Nature, 80. pp. 219–221, April 22, 1909.)—The meteorological cruises of the steam yacht *Otaria* organised by the authors in 1905, 1906, and 1907 extended from the neighbourhood of the Azores to Ascension Island, and as far west as longitude 47° [see Abstracts Nos. 191, 797 (1907)]. Their main object was to investigate the south-westerly anti-trade wind, on the existence of which, as a normal phenomenon, doubt had been cast by the results obtained by Hergesell. From a considerable number of ascents we derive the result that the normal stratification of the atmosphere in the (north) trade wind zone is as follows: The lower stratum, having a drift from NE. shows a rapid decrease of temperature (0·9° to 1·8° C. per 100 m.) in the first 500 or 600 m. Above this zone there is an inversion of temperature in which the wind velocity diminishes. Above the trade wind there is generally a current from the NW., then, at about 2,500 m. near the Tropic of Cancer and at 3,000 or 3,500 m. in more northerly regions, there occur winds having a component from the south. The direction is from SE. near lat. 15° N. and from WSW. near lat. 25° N. Similar changes with altitude were found in the south-east trade wind near Ascension. The isothermal layer was met with in lat. 25° 18′ N. at 14 km. Further north it was found at heights varying between 12 and 14 km. It was not reached to the south of lat. 25° N.

R. G. K. L.

986. *Periodicity of Thunderstorms.* **Y. Homma.** (Mathematico-Physical Soc., Tōkyō, Proc. 5. 2. pp. 12–42, Feb., 1909.)—The author has examined the data of the occurrence of thunderstorms in Prussia for the period 1891–1900, contained in the Year-books of the Prussian Meteorological Institute, with the object of determining a periodicity in the phenomena. From a comparison of the results for the two separate lustra included in this interval he concludes that the existence of a period of about 26 days, as found by v. Bezold, is very doubtful. His own investigations point to a period of 12·025 days.

R. G. K. L.

987. *The Density of Snow.* **A. Defant.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 1231–1249, Oct.–Nov., 1908.)—Measurements of the density of snow were made on the Sonnblick (3,106 m.) during the summer of 1908. In the first set of measurements the density increased from 0·280 at 12·5 cm. to a maximum, 0·682 at 87·5 cm. The subsequent minimum occurred at 162·5 cm., below which level there was a further increase until, at 312·5 cm., the value 0·607 was reached. A second series of experiments, made at a different spot,

also showed a maximum (0·564) at 87·5 cm. The subsequent minimum was found at 112·5 cm.; below this level the density increased rapidly to 0·795 at 187·5 cm. The increase of density with depth is not linear, as is sometimes supposed. For the several branches of the curves it may be represented approximately by a logarithmic formula. The increase of density is found to be due to the expulsion of air-bubbles from between the snow crystals by increased pressure. R. G. K. L.

988. *The Yielding of the Earth to Disturbing Forces.* **A. E. H. Love.** (Roy. Soc., Proc. Ser. A. 82. pp. 73–88, Feb. 16, 1909. Abstracts in Nature, 80. pp. 252–253, April 29, 1909. Roy. Astronom. Soc., Monthly Notices, 69. pp. 476–479, April, 1909.)—Various methods of estimating the rigidity of the earth are passed in review, based partly on different hypotheses as to the earth's internal constitution, partly on different observations from which a deformation of the earth's surface can be inferred. The observations are concerned with tides of long period, variations of the vertical, and variations of latitude. The earth's defect from rigidity is found by comparing the actual state of things with what would occur theoretically, under the existing disturbing forces, if the earth were absolutely rigid. To begin with, the earth is assumed to be of uniform density and rigidity, and absolutely incompressible. Then the effect of heterogeneity on the estimate of rigidity is investigated. Different estimates are obtained when different laws of density are assumed. Further, with the same law of density different estimates of the rigidity are obtained by using observations of different phenomena. It follows that "the rigidity of the earth" is not a definite physical constant. But there are two determinate constant numbers related to it. One of these, h, specifies the amount by which the surface of the earth yields to forces of the type of the tide-generating attractions of the sun and moon. The other, k, specifies the amount by which the potential of the earth is altered through the rearrangement of the matter within it when this matter is displaced by the deforming influence of the sun and moon. In the present work, the values $h = \frac{3}{5}$ nearly and $k = \frac{4}{15}$ nearly are found. The ratio of the observed deflection of the pendulum to that which would occur if the earth were absolutely rigid is $1 + k - h : 1$. It is well known that the ratio of the height of the long-period tides to the true equilibrium height is also $1 + k - h : 1$. Kelvin, Schweydar, and Hecker have found that $1 + k - h = \frac{2}{3}$. If the earth were absolutely rigid the variation of latitude period discovered by Chandler would be 306 days instead of 427. In order to obtain an estimate of the rigidity of the earth from observations of the variations of latitude, it is desirable to adopt some hypothesis which will admit of the ellipticity and the precession constant having their actual values. In Wiechert's hypothesis, which fulfils these conditions, the earth is taken to consist of a solid nucleus of density 8·2 enclosed in a solid shell of density 3·2, the ratio of the radii being 0·78. If the matter be assumed of uniform rigidity and incompressible, estimates of rigidity deduced from different kinds of observations give discordant results, showing that the assumption is untenable. Schweydar has proposed to assume one uniform rigidity for the nucleus and another for the shell. The observations can be reconciled by taking the rigidity of the nucleus to be much greater than that of ordinary materials at the surface, and the rigidity of the shell smaller than that of most rocks. Wiechert has further suggested that there may exist a plastic sheet between the nucleus and the shell. The present results lead to the conclusion that there is certainly not within a depth of 1,400 km. a continuous

layer of molten matter, separating the inner portions of the earth from the outer portions, and behaving as a fluid in respect to forces of the type of tide-generating forces. Analysis is given from which it appears that, even if the solid nucleus were absolutely rigid, and the enclosing shell 1,400 km. thick, the presence of a layer of fluid between the nucleus and the enclosing shell would increase very much the yielding of the surface. To prevent the surface from yielding more than it actually does, the rigidity of the shell would have to be nearly five times that of steel. If the enclosing shell were 64 km. thick, its rigidity, the nucleus being absolutely rigid and the fluid layer thin, would have to be 66 times the rigidity of steel. These numbers are advanced as decisive as against the hypothesis of the fluid layer. This conclusion does not negative the possible existence of areas of molten matter of continental dimensions under the earth's crust, but asserts that such areas must be isolated. The conclusion does not negative the possible existence of a layer of comparatively small rigidity; but if there is such a layer, it must be rigid enough to prevent a finite slipping of the enclosing crust over the central body. A. E.

989. *Terrestrial Magnetism and Vulcanism.* **J. J. Taudin Chabot.** (Phil. Mag. 17. pp. 655–656, April, 1909.)—The spontaneous radio-activity of various substances exhibits a definite dependence upon atomic weights inasmuch as it has been detected in those bodies whose atomic weights have the highest known values, being first observed in a uranite, immediately afterwards in thorium, and later in radium, which has possibly the highest known atomic weight. Now radium follows bismuth in a direct series leading up from radio-active lead; bismuth forms, in combination with manganese, a strongly magnetic substance whose special property is that the magnetic condition is predominant in the *heated* state at temperatures between 2,000° and 2,800° C. The question then arises that if radio-active processes constitute the source of internal heat of our planet, to what extent may they at the same time determine its magnetic state? The phenomena will, of course, partly be determined by the results of friction and pressure due to internal and crust movements. C. P. B.

990. *The Cause of the Heat of Rocks.* **J. A. Le Bel.** (Comptes Rendus, 148. pp. 960–962, April 5, 1909.)—The author has previously found that different materials, in particular granite and sand, when surrounded by a layer of asbestos, manifest a temperature from 0·02° to 0·08° above that of their surroundings. These observations have been confirmed and attributed to the radio-active material contained by the rock under examination. A series of experiments are now recorded which tend to demonstrate that the nature of the material immediately surrounding the rock has a great influence on the excess of temperature which it exhibits. The explanation is offered by the author that the principal part of the heat is not due to the radio-activity of the rock itself, but is the effect of radiations which reach it from the exterior. A. E. G.

991. *The Volcano of Ōshima, its Past and Present.* **S. Nakamura, T. Terada, and D. Isitani.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 15. pp. 298–312, April, 1908.)—A descriptive paper, geographical, topographical, historical, and general. The volcano is situated on the island of Ōshima, one of the Seven Islands of Izu, all volcanic. The central cone rises to 755 m. above sea-level, and has a circular crater of 850 m. radius. The literature

goes back to 1724. The first recorded eruption took place in 684. The eruption of 1877 was described by O. E. Naumann, J. Milne, and T. Wada. As a rule the crater is very quiet; the fumes consist of SO_2 (not of H_2S). Most of the fumaroles are within the crater or on the crater walls; their temperature is very steady about 56°. The one exception, the fumarole at Yuba, 8 km. from the cone, has a fluctuating temperature, and it has been observed that on days of weak activity there is alternating exhalation of steam and inhalation of cold air. From a hole at Nomashi, about 300 m. from the seashore, odourless, dry, and cold air issues continuously at a temperature of 14° C.; all the temperature estimates mentioned in this Abstract refer to August. The ion-counter of Ebert gave 847 ions (means of positive and negative) near the crater, 702 at Yuba, and 332 at Noshima. H. B.

992. *Peculiarity in Seismograms al Rocca di Papa of Calabrian Earthquakes of September* 8, 1905, *and December* 28, 1908. **G. Agamennone.** (Accad. Lincei, Atti, 18. pp. 339–343, April 4, 1909.)—Seismograms of these two earthquakes show that in each case the first indication of the earthquake at Rocca di Papa, as well as at many other observatories, was a slight wave, having a velocity of 7–8 km. per sec., and a period of about 18·5 sec., corresponding to a wave-length of about 135 km. The inclination produced by this initial wave was very small, being in 1905 only about 0·8″ and 1·7″ as measured by two different instruments, and in 1908, 2″ and 2·8″. W. H. Si.

993. *Propagation of Seismic Waves.* **G. Agamennone.** (Accad. Lincei, Atti, 18. pp. 393–398, April 18, 1909.)—To explain the low-period wave observed at the commencement of the Calabrian earthquakes of 1905 and 1908 [see preceding Abstract], the author suggests that in very intense earthquakes, with hypocentres which are not very deep, gravitational waves are first formed around the epicentre, having very small amplitude but very high velocity. Waves of other kinds may coexist with these, but their velocity certainly cannot exceed that of the low-period wave. W. H. Si.

994. *Radial Movements in Sun-spots.* **J. Evershed.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 454–457, March, 1909.)—Line-shifts of a character not previously recorded have recently been photographed at Kodaikánal in sun-spot spectra. They are permanent, affect most, if not all, of the Fraunhofer lines, and are greatest in the penumbra. In these respects they differ from the displacements frequently observed in spot disturbances where active change is in progress, which, as a rule, seem only to affect the elements of the higher chromosphere, last only a few minutes, and are rarely found within the penumbral area of a spot. From 150 spectra of 11 spots, the following results have been obtained regarding the newly discovered displacements. They are of about the same order of magnitude, at the same distance from the centre of the sun's disc, disappear when the spot is within 10° of the centre, are most marked between 30° and 50° from the central meridian, and are of opposite sign on opposite sides of the central meridian. The displacements are towards the violet on the preceding side of a spot, and towards the red on the following side, when the spot is east of the central meridian; the reverse when west. No displacements are obtained when the slit bisects a spot in a direction at right angles to a line joining the spot and the centre of the sun's disc—a fact which negatives the hypothesis of a vortex,

or rotation of any kind, about an axis perpendicular to the sun's surface. A hypothesis attributing the displacements to a radial motion outwards from the spot centre seems in harmony with the facts. The motion must be parallel to the sun's surface, as is shown by the disappearance of the line-shifts when the disturbance is near the centre of the disc. The hypothesis of a radial motion, which is strongly supported by the observations, hardly agrees, however, with Hale's discovery of the Zeeman-effect in sun-spots, which seems to demand a circular motion. The new theory would explain the radial structure of the filaments in the penumbræ, the radial disposition of the calcium flocculi surrounding a spot, and also the tendency of the principal spots in a group to separate, the leader advancing and the follower receding. As regards the appearance on the photographs, the portions of the spectrum lines crossing the spot band, though straight over the spot, are inclined one or two degrees to the lines in the neighbouring photosphere. A difficulty is mentioned. The greatest shift occurs at the outer limits of the penumbra, thus seeming to imply an accelerating movement from the centre of the spot outwards; yet at the limits of the penumbra the motion apparently ceases abruptly. The max. total displacement obtained with the slit in the direction of the centre of the disc is 0·040 Å.U. at λ4850, for a spot 40° W. of the central meridian and 9° N. This gives a component velocity in the line of sight 1·24 km. (towards the observer on the following side of the penumbra), and an actual motion parallel to the sun's surface of 1·9 km. per sec. A. E.

995. *New Aspect of Celestial Spectroscopic Phenomena.* **H. F. Newall.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 333–344, Feb., 1909. Presidential Address.)—A review is given of a possible explanatory theory of the spectroscopic phenomena of the sun and stars on the hypothesis that they are mainly dictated by matter continually streaming in from without and not mainly by matter brought from within the body of the sun or star. The chief difficulty with regard to the generally accepted classifications is that there is no one criterion employed for the different series, one characteristic being utilised for certain groups and another for others. The phenomena of cometary tails, for instance, appears to require the existence of freely distributed cosmical matter, which may be excited to varying degrees of luminescence. A lengthy discussion of this and the enormous extensions of matter constituting the solar corona results in the idea that on all cosmical bodies we have continuous accretions of matter. The effect of this in the case of our own sun on the change in length of the terrestrial year is computed and the investigations of Cowell on ancient eclipses are directly applicable to this idea. C. P. B.

996. *The Clouds of Venus and their Significance.* **A. W. Clayden.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 195–204, Jan., 1909.)—Assuming that the visible surface of Venus is the outer face of a heavily cloud-laden atmosphere comparable in mass and composition with our own, certain deductions are based on its observed features. A discussion of the way in which those clouds should be distributed according to different views as to the period of rotation, and the position of the polar axis, leads to the inferences that the planet's day and year cannot be identical; that the axis is highly inclined to the plane of the orbit; and that the rotation period is long—so long that the law of equal areas, Ferrel's law of the deflection of currents moving over a rotating body, and the laws of centrifugal force, do not exercise any domi-

nating effect on the atmospheric circulations. The atmospheric conditions as to pressure, currents, and cloud, &c., which would prevail under these circumstances are discussed, and it is claimed that they furnish a simple explanation of certain telescope phenomena characteristic of the planet. Such are, the brightening of the limb relative to the rest of the disc, the prolongation of the cusps, detached points beyond the horns, various appearances at the terminator, the mottling of the surface, and the ring of light seen at inferior conjunction and usually attributed to atmospheric refraction, but which is here accounted for as merely the edge of an illuminated shell of cirrus cloud. Finally, it is suggested that if the convection clouds do not form a continuous sheet, but have clear intervals for descending partial currents, it may sometimes be possible to penetrate the veil. On the other hand, it may be that those sharply defined markings which have been recorded are a result marked out upon the cloud veil by the surface features hidden beneath.

A. E.

997. *Brightness of Saturn with Ring Invisible. Correction.* **J. M. Baldwin.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 458–459, March, 1909.)—In a paper on photometric measurements of Saturn [Abstract No. 1057 (1908)] a mistake was made, the correction given for reducing the observed brightness to the brightness at mean apposition being only half as great as it should be. The correct values are now shown in a new table. To find if there is any variation of the brightness of the spheroid of Saturn with the phase the observations have been further reduced by applying Seeliger's reduction to "ring invisible." These reduced values are plotted in a diagram, from which it appears that the alteration in brightness with phase angle, if any, must be very slight, and that many more observations are necessary to determine it.

A. E.

998. *Note on Franks's Analysis of the Colours and Magnitudes of 8,680 Stars.* **J. Bell.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 420–421, March, 1909.)—Franks's tables, when treated by the method of contingency [see Abstract No. 796 (1909)], give the following results, if C_2 be the coefficient of mean square contingency: Combined galactic regions, $C_2=0{\cdot}22$; combined non-galactic regions, $C_2=0{\cdot}18$; total stars of both series, $C_2=0{\cdot}19$. It would appear that the measure of relationship between luminosity and colour is slightly higher in the galactic regions. Previous values for the contingency of magnitude and colour [Gibson and Pearson, Abstract No. 1059 (1908)] are $C_2=0{\cdot}30$ and $0{\cdot}27$, but they were for photographic, while Franks's results are for visual, magnitudes. Franks's table of the percentages of the different colours in galactic and non-galactic regions is here made the basis of an inquiry into the probability of the stars of either of the two groups being "random samples" of stars in general, by applying Pearson's criterion of "goodness of fit" (Phil. Mag. 2. p. 157). The conclusion arrived at is that, while some stress must be laid on the colour differentiation between galactic and non-galactic stars, it is still not one of the kind which produces a sweeping conviction that it is of fundamental importance. The divergence does not exceed that given by ordinary dice, which are usually loaded, though not intentionally.

A. E.

999. *Stellar Magnitude Scales for Astrographic Catalogue.* **H. H. Turner.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 392–402, March, 1909.)—A difficulty in connection with the comparisons of plates from different observatories is the adoption of different procedures for estimating magnitudes by different observatories, thus rendering the work of co-ordination uncertain. It is suggested that systematic counts of the number of images shown under each number of the magnitude scale be made at each observatory. C. P. B.

1000. *Motions of Ursæ Majoris Stars.* **H. Ludendorff.** (Astronom. Nachr., Nos. 4818–4. Nature, 80. p. 141, April 1, 1909. Abstract.)—An attempt is made to discuss the question of physical relationship between the seven Ursæ Majoris stars, using the results of radial velocities determined at Potsdam. The discussion indicates that two systems are involved, both of which have approximately the same parallax and velocity relative to the sun, but the angle between the directions of the two systems is about 101°.

C. P. B.

1001. *The Possibility of Fission of a Contracting Rotating Fluid Mass.* **F. R. Moulton.** (Astrophys. Journ. 29. pp. 1–18, Jan., 1909. Abstract of paper published by the Carnegie Institution.)—The question is considered with reference to the origin of binary stars. It has been shown by investigators that, for homogeneous fluid masses of the same density but different rates of rotation, there is a continuous series of figures of stable equilibrium, beginning with the sphere for zero rate of rotation; then with increasing rotation, passing along a line of oblate spheroids until a certain rate of rotation is reached; then with decreasing rotation but increasing moment of momentum, branching to a series of ellipsoids until a certain elongation is reached; and finally, at this point, branching to a series of so-called pear-shaped figures. It has been conjectured that the pear-shaped figures would eventually reach a point where they would separate into two distinct masses. From this it has been inferred that celestial masses, through contraction from loss of heat, do break up in this way often enough to make the process an important one in cosmogony. Aside from the unanswered question as to what form the pear-shaped figures finally arrive at, there are two reasons for caution in accepting this inference: one is that the celestial masses are by no means homogeneous, but are strongly condensed towards their centres; the other is that isolated celestial masses do not change their rates of rotation except when they change their densities or distribution of densities. The importance of not neglecting the change in density is explained. Supposing the mass contracts in such a way as to remain homogeneous, and to continue to rotate as a solid spheroid, the eccentricity will be acted upon by two opposing factors, one tending to increase, the other to decrease, the oblateness. If under the influence of these factors, the figures should become less oblate, the fission theory would get no support; if it should get more oblate, the question is at what rate the mass must rotate, and to what extent the contraction must proceed, before there is a possibility of fission. The paper is devoted to a brief discussion of this question. Successive paragraphs deal in turn with the ellipsoidal figures of equilibrium of rotating homogeneous fluids, Poincaré's theorems respecting forms of bifurcation and exchange of stabilities, figures of equilibrium of rotating heterogeneous fluids, and the conditions of equilibrium for constant moment of momentum. Then follow applications of the results to the solar system, and to binary stars. The conclusion is reached that, notwithstanding the lack of numerical precision due to the great difficulties of the problem, it is justifiable to infer that there has been no example of the type of fission under consideration in the solar system, and that there will be none in the future. In the case of the binary systems the only conclusion obtained is that in systems made up of approximately equal pairs, and in which the periods are at least several years, fission has taken place, if at all, while the mass was yet in the nebulous state. It is not affirmed that any evidence has been brought forward that fission ever occurs, and for masses with densities decreasing outwards, fission into two stable masses is regarded as extremely improbable. It has been assumed that the celestial evolution is from the nebulous state to the stars, but a concluding suggestion is added that there are now abundant reasons for rejecting Laplace's hypothesis as applied to the solar system, and that the time may be ripe to try if the opposite hypothesis of the disintegration of matter, owing to enormous subatomic energies released in the extreme temperatures and pressures prevailing in the interior of suns, cannot be made to satisfy all known phenomena. A. E.

1002. *Relative Brightnesses of the Four Comets Associated with Meteor Showers,* 1861 I., 1862 III., 1866 I., *and Biela.* **J. Holetschek.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 1015–1048, July, 1908.)—The investigation of a long series of comets led to the conclusion that from the brightness, reduced to unit distance from the sun and earth, a basis for the comparison of comets may be obtained. Also that from this reduced brightness, combined with the perihelion distance, the variations of brightness and tail development can be inferred with some degree of probability. Going a step further, it is now suggested that the masses of comets also vary nearly with the reduced brightness, when the perihelion distances are nearly equal. To test this point, the four comets named in the title were selected for examination, as being of special interest. Observations were collected, and the reduced brightnesses calculated. The apparent diameters were also reduced to unit distance from the earth, and the true lengths of the tails calculated from the apparent lengths. The values given for the reduced brightness and diam. respectively, are the following: Comet 1862 III. (Perseids), 4·3 mag., 6·3. Comet 1861 I. (Lyrids), 5·6 mag., 5·5. Comet Biela (Andromedids), 8·1 mag., 2·0. Comet 1866 I. (Leonids), 9·0 mag., 1·8. The tail development is found also to diminish with the brightness in the same way as in the other comets investigated. The fact that meteor streams are given off appears to have little effect on the tail development, with a possible exception is the case of Biela's comet. It is remarked that the meteor showers associated with the two brighter comets return year after year with something like the same intensity, while the showers associated with the two fainter comets are especially rich in certain years separated by intervals nearly equal to the periods of the comets in question. A. E.

1003. *Spectrum of Comet Morehouse* (1908*c*). **A. de la Baume Pluvinel** and **F. Baldet.** (Comptes Rendus, 148. pp. 759–762, March 22, 1909.)—In a former paper [Abstract No. 1914 (1908)] the authors have described certain peculiarities in the spectrum of this comet. They subsequently employed an instrument of greater dispersive power, and give the more accurate values of the determined wave-lengths obtained. In all 21 doublets have been detected, and treating these as the heads of bands under Deslandres' law, it has been possible to separate the lines observed into four series—two strong, the other two weak; these are given in comparison with the computed values. These do not correspond with the band spectrum of any known substance. Besides the above the usual cyanogen bands are well marked, and the hydrocarbon bands, although certainly present, are only feeble. **H. Deslandres, A. Bernard, and J. Bosler.** (Ibid. pp. 806–812, March 29, 1909.)—In continuation of previous notes [Abstracts Nos. 1914 (1908), 88 (1909)] the authors give a discussion of the later photographs. The three unknown bands found in Comet Daniel (1907*d*) at λ456, 426, 401, were well shown in Comet Morehouse, and it is important to note that they were strongly developed in the spectrum of the tail matter. The cyanogen bands at 388 and 387 are the only ones present. A new band at 3914 was found, which remained single under increased dispersion, while the new lines above mentioned were shown to be double. C. P. B.

1004. *Gases of Ring Nebula in Lyra.* **B. Brauner.** (Nature, 80. pp. 158–159, April 8, 1909.) — Wolf, working at Heidelberg with a prismatic reflector, has photographed the spectrum of the ring nebula in Lyra, and shown that it indicates a separation of the ring matter into four gases of different densities, evidenced by the varying diameters of the spectral images. As this may be due to the centrifugal action, it may be possible to compute the probable densities of the unknown gases, and thus provide a possible clue for the detection of the element terrestrially. An atomic weight of 0·4 is indicated for one of the missing elements. C. P. B.

1005. *Spectra of Nebulæ.* **J. Eberhard.** (Astronom. Nachr., No. 4318. Nature, 80. p. 229, April 22, 1909. Abstract.)—Commenting on the recent photographs of the spectra of gaseous nebulæ obtained by Wolf at Heidelberg [Abstract No. 797 (1909)], attention is directed to the irregularities in the notation with which the nebular lines were described. Supposed cases of double lines may more probably be juxtaposition of non-related lines owing to the small dispersion. C. P. B.

REFERENCES.

1006. *Mercury Air-pump and Vacuum Meter.* **U. v. Reden.** (Phys. Zeitschr. 10. pp. 316–319, May 1, 1909.)—A detailed description with six figures of a new and compact form of mercury air-pump (used in conjunction with a water aspirator) and a spiral vacuum meter, claimed to be superior to the McLeod gauge. E. H. B.

1007. *Composition of Harmonic Vibrations.* **A. Garbasso.** (Accad. Sci. Torino, Atti, 44. 5. pp. 139–148, 1908–1909.)—The author solves the problem of a small platform suspended in the manner of a pendulum, and from which *n* pendula of various lengths are suspended. At the end of the paper is given a diagram of the apparatus showing the manner of suspension and of recording the motion of the table, and also a set of curves giving the resultant vibration when different pendula are hung from the platform and which are in agreement with the result of calculation. S. G. S.

1008. *Matter and Energy.* **C. L. Speyers.** (Science, 29. pp. 656–659, April 23, 1909.)—Criticism of Lewis' reasoning as to mass becoming infinite at the velocity of light [see Abstract No. 11 (1909)]. A. D.

1009. *Depression of the Filament of Maximum Velocity in a Stream Flowing through an Open Channel.* **A. H. Gibson.** (Roy. Soc., Proc. Ser. A. 82. pp. 149–159, May 6, 1909.)—The original pages should be referred to by those interested in the gauging of streams. L. H. W.

1010. *Hydrodynamics.* **P. Forchheimer.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 1109–1126, Oct.–Nov., 1908.)—A mathematical discussion of some abstruse underground-water phenomena. A. W.

1011. *Meteorological Observations at Moscow.* **E. Leyst.** (Soc. Imp. Nat. Moscow, Bull. 4. pp. 552–591, 1907.)—The paper contains a very full discussion of the climatological observations (made at 7h., 13h., and 21h.) at Moscow. R. G. K. L.

1012. *Twilight Observations.* **A. Miethe** and **E. Lehmann.** (Meteorolog. Zeitschr. 26. pp. 97–114, March, 1909.)—The paper contains a detailed description of morning and evening twilight phenomena observed at Assuan from Feb. 8 to March 9, 1908. R. G. K. L.

1013. *Föhn Occurrence in Switzerland.* **J. Maurer.** (Meteorolog. Zeitschr. 26. pp. 165–170, April, 1909.)—A statistical examination of the data on Föhn occurrence in Switzerland during the past 40 years. R. G. K. L.

1014. *Orbit of Jupiter's Eighth Satellite.* **P. H. Cowell, A. C. D. Crommelin,** and **C. Davidson.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 421–431, March, 1909.)—The orbit of the newly discovered eighth satellite is computed from the positions observed at the oppositions of 1908, 1909, and the results plotted in a curve showing the departures of observed from computed values. A diagram of the orbit is given. C. P. B.

1015. *Circularity of Planetary Orbits.* **T. J. J See.** (Astrom. Nachr., No. 4308. Nature, 80. p. 229, April 22, 1909. Abstract.)—Discussion of the origin of planetary systems on the supposition that they are due to outside masses coming into the sphere of action of a central nebulous magma. C. P. B.

1016. *Motion of the Centre in the Variable System δ Cephei.* **A. Bélopolsky.** (Acad. Sci. St. Pétersbourg, Bull. No. 4. pp. 249–278, March 1, 1909.)—The author's investigation is based upon the spectrograms obtained at Pulkova in the period 1894–1908. The original pages should be referred to for the tabulated results. T. H. P.

1017. *Magnitudes and Colours of Stars.* **Müller** and **Kempf.** (Astronom. Nachr., No. 4312, p. 249, 1909. Nature, 80. p. 108, March 25, 1909. Abstract.)—Discussion of relation between magnitudes and colours of 14,172 stars of the Potsdam Photometric "Durchmusterung." Four divisions of colour are treated separately—white, yellowish-white, whitish-yellow, and yellow. The greatest number occur as yellowish-white stars. C. P. B.

1018. *Apparent Dispersion of Light in Space.* **P. Lebedew.** (Astrophys. Journ. 29. pp. 101–109, March, 1909.)—A further discussion setting out the author's views [see Abstract No. 1764 (1908)] on this subject.

1019. *New "Cave Nebula" in Cepheus.* **M. Wolf.** (Roy. Astronom. Soc., Monthly Notices, 69. p. 117, Dec., 1908.)—Description of a newly discovered nebula from photographs taken with the Bruce photographic telescope at Heidelberg on Oct. 21, 1908. It forms the end of a long starless lacuna in the Milky Way, directed from south to north, and has a bright condensation. C. P. B.

1020. *Time of Minimum Phase of Algol-Variable Star.* **H. C. Plummer.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 417–420, March, 1909.)—Analyses of the computation of the dimensions of orbit of the dark component, and the masses of the stars of an Algol variable from a knowledge of the instant of minimum phase used in conjunction with a spectrographic determination of the orbit of the bright component. C. P. B.

LIGHT.

1021. *A Simple Fabry and Perot Interferometer.* **J. Barnes.** (Nature, 80. pp. 187–188, April 15, 1909.)—A very simple and inexpensive Fabry and Perot interferometer can be constructed of plate glass, which gives good results, the D lines from a sodium burner being easily separable. If the interference pattern, using a copper or iron arc, is focussed on a wide slit of a single-prism spectrometer, a section of the interference rings is seen in the various spectrum lines, illustrating the method of Fabry and Buisson, and Eversheim, for the new standard determination of wave-lengths. The Zeeman-effect can also be easily shown with this apparatus. Two pieces of plate glass about 1 in. square are taken and silvered until one surface of each plate cuts down the intensity of the transmitted light to about a quarter of the incident light. The silvered surfaces are separated by two strips of cardboard. A thickness of about 0·45 mm. may first be used, as this clearly separates the D lines. The plates are mounted over a ½-in. hole in a metal plate by means of three pressure screws. On looking normally through the plates at the glowing filament of an incandescence lamp a number of images of it will probably be seen. When the pressure screws are adjusted until these images are in juxtaposition in the line of sight the silvered surfaces are approximately parallel. The instrument may then be placed in a clamp stand and the light from a sodium flame or a vacuum tube focussed upon the plates, and the interference bands examined with a small telescope focussed for infinity. (It is usually better to replace the eyepiece by a single lens of 2 in. focal length.) At first only a small section of the interference pattern is seen, but with a little careful adjustment of the pressure screws the whole ring system is obtained in sharp focus. On removing the telescope and using the lens referred to as eyepiece the interference system from the above sources or an arc may be focussed upon the slit of a spectroscope. The bands in the different spectrum lines may thus be observed with the telescope on the spectrometer. [See also Abstract No. 1643 (1904).] J. J. S.

1022. *A Divergent Magnifier for Microscopes.* **A. Berget.** (Comptes Rendus, 148. pp. 1097–1099, April 26, 1909.)—The usual method of obtaining large magnifications is to employ, with a given eyepiece, an objective of very short focus, the distance of the object from the objective being very small. The same magnification may be obtained, while keeping the object distance moderate, by placing a concave lens of short focus behind the objective to magnify the real image formed by the latter. With the lens and microscope employed an additional magnification of seven times was obtained with an object distance of 1 cm., which would otherwise have been a small fraction of a millimetre. Various applications of the method are suggested.

G. E. A.

1023. *New Applications of the Spectroheliograph.* **H. Deslandres.** (Comptes Rendus, 148. pp. 968–974, April 18, 1909.)—In the ordinary type of spectroheliograph at present in use at various observatories, the simple rectilinear movement of the whole instrument does not permit of any direct variation of the size of image photographed, nor of sufficient dispersion to efficiently isolate the fine centre core lines H_3 or K_3, corresponding to the highest layers of the solar atmosphere. A new apparatus is described which is practically compounded of four spectroheliographs, each of different power, in which the necessary transit over the solar image is controlled by synchronised electric motors. C. P. B.

1024. *Attempt to Detect Electro-optical Effects.* **H. A. Wilson.** (Roy. Soc., Proc. Ser. A. 82. pp. 224–226, May 6, 1909.)—A description of experiments made to detect, if possible, electro-optical effects, the results obtained being, however, negative. A square frame of glass bars was used. Light entered vertically at one corner and was divided, by a half-silvered surface at an angle of 45°, into two beams which traversed the frame in opposite directions, suffering reflections at bevelled surfaces at the other three corners. These two beams then issued horizontally from the original corner, and in a condition to interfere. It is believed a displacement of one-fiftieth of a band could have been detected. But no such shift was observed although the frame was subjected to (1) a rapidly alternating e.m.f., (2) a powerful jar discharge, (3) the effect of a Hertz oscillator, (4) a magnetic field, (5) the very strong field of a Du Bois magnet, (6) a strong electrostatic field, (7) the circulation of water in rubber pipes round it. E. H. B.

1025. *Anomalous Propagation of Spherical Waves through Foci.* **F. Reiche.** (Ann. d. Physik, 29. 1. pp. 65–98, April 22, 1909. Physikal. Inst. d. Univ., Breslau, Feb., 1909.)—On the basis of the electro-magnetic theory this paper deals with the change of phase of spherical radiation in passing through foci, which points are regarded as a combination of sink and source or a sort of "through station" for the energy of the waves. E. H. B.

1026. *Absorption of Ultra-violet Light by Dilute Solutions.* **F. B. Pidduck.** (Phil. Mag. 17. pp. 710–715, May, 1909.)—Curves are given showing the variation of absorption with concentration in solutions of NaCl and KBr. Absorption by tap-water is found to be different from that of distilled water, and also from artificial tap-water. The probable causes of this difference are: the efficacy of small suspended particles, difference of dissociation of the salts in the two cases, or the presence of a large number of unknown salts in small quantities. The first of these is not of great power, since tap-water when sterilised and filtered is rendered more opaque. Measurement of the resistance of the same column of the various liquids by an electrometer method was carried out, and it is concluded that the most probable cause of the superior absorption of tap-water is the existence in it of large numbers of different salts in very small quantities. G. E. A.

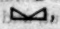
1027. *Absorption and Reflection of Calcite and Aragonite.* **R. E. Nyswander.** (Phys. Rev. 28. pp. 291–308, April, 1909.)—A research on the reflecting and absorbing powers of the two crystals for infra-red rays as dependent on the plane of polarisation. A selenium reflection polariser is used in conjunction with a Nichols radiometer, the source being a Nernst heater. The curves obtained exhibit the percentage energy reflected and transmitted by the specimens for the part of the spectrum lying between $1\cdot7\,\mu$ and $15\,\mu$; they show three regions of characteristic bands at $6\cdot6\,\mu$, $11\cdot5\,\mu$, and $14\cdot1\,\mu$ respectively. It is concluded that, from the physical similarity of the anhydrous carbonates of the calcite and aragonite groups, it may be assumed with safety that any characteristic of one of the members will apply equally well to all of the carbonates of that group. G. E. A.

1028. *Optical Properties of Gold, Platinum, and Silver in Colloidal Solutions.* **B. J. Spence.** (Phys. Rev. 28. pp. 233–263, April, 1909.)—Using stable colloidal solutions of gold, platinum, and silver in water or ethyl malonate, made by the method of Burton [Abstract No. 968 (1906)], the author operated with a large spectro-bolometer specially designed by A. Trowbridge, and with light from a Nernst lamp passed through a rock-salt prism observed the absorption coefficients for different thicknesses of solution. The chief results and conclusions are as follows: 1. The difference between the absorptions of the colloidal solution and of the supporting medium is directly proportional to the concentration. For turbid media this cannot be said to be the case generally, owing to the variation of the size of the particles for different media. 2. The Rayleigh formula, $H = 32\pi(n^2 - 1)/3n\lambda^4$, where H is the absorption, n the refractive index of the particle, and λ the wave-length, holds neither for the case of turbid media, for which it was developed, nor for the colloidal solutions. The law of absorption cannot be stated definitely from this work. A number of curves are given. 3. The values of the refractive indices, n, for the metals, determined by this method are independent of the supporting medium, and are strictly inherent properties of the metals themselves. 4. The final test as to the correctness of the analysis by means of the equation of Drude—

$$R = \frac{(n^2 - 1)^2 + a^2}{(n^2 + 1)^2 + a^2},$$

where R is the reflection coefficient and a the absorption coefficient, places beyond question the values of the refractive indices obtained for the metals Au, Ag, and Pt.

The wave-lengths dealt with are for soda light to 1·5 μ, and the detailed results occupy four diagrams and twelve tables. E. H. B.

1029. *Determination of Refractive Index by Means of the Microscope.* **E. Clerici.** (Accad. Lincei, Atti, 18. pp. 351–355, April 4, 1909.)—An improvement is described in the author's method (Ibid. 16. p. 336), in which a small glass prism is attached to the bottom of a hollow cylindrical cell, on the under-surface of which is scratched a straight line. The position of this line is then observed before and after the cell is filled with the liquid under examination. The improvement consists in replacing the single prism by two prisms which may take any of the forms , , or . The second one is to be preferred, as the upper surface then serves to hold a microprism of the liquid. With such an apparatus, the cell being 6–7 mm. deep, and the prisms having angles of about 40°, refractive indices can be read to 0·00168. W. H. Si.

1030. *Focal Length by Autocollimation.* **H. Erfle.** (Deutsch. Phys. Gesell., Verh. 11. 6. pp. 161–166, March 30, 1909.)—Several expressions are found for the effect of slight curvature of the mirror employed in determining focal lengths by autocollimation. One of these is $f = F + (F^2/2f')$, where f is the real and F the observed focal length, and f' the focal length of the mirror. This form shows that curvature of the mirror exercises a greater effect on the larger values of f. G. E. A.

1031. *Can Depth of Definition be corrected?* **W. Schmidt.** (Zeitschr. wiss. Phot. 7. No. 4. pp. 138–143, and No. 5. pp. 145–156, April, 1909.)—

A mathematical discussion of the aberration of depth in photographic objectives—an error hitherto supposed to be insurmountable. With constant equivalent focal length and variable focal length of the units of the system, the depth of definition can be altered, being greatest for the combination, not used in practice, of a front concave lens with a back convex lens, and least for the tele-objective type in which the order of the lenses mentioned is reversed. G. E. A.

1032. *Enfeeblement of Light passing normally through Parallel Glass Plates.* **H. Lunelund.** (Phys. Zeitschr. 10. pp. 222–224, April 1, 1909.)—The diminution of amplitude is known by the Fresnel-Neumann formula to depend upon the refractive index when light is reflected or refracted at the face of a transparent medium. If a single parallel plate is used, infinite series of both reflections and refractions occur; when a number of plates are used the phenomena are correspondingly complicated. The author has worked out several formulæ and tested them by photometric observations with a Nernst lamp and from 6 to 16 mirror plates packed close or separated. The observed ratios of intensities transmitted with close packing and separation were 1·4165 for 6 plates and 2·2550 for 16. The values calculated by the formulæ were very close to these, the differences between theory and experiment being 0·0102 for the 6 plates down to 0·0004 for the 16 plates. E. H. B.

1033. *New Methods of Stereoscopy.* **P. H. Eykman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 832–840, April 22, 1909.)—The methods described refer to stereoscopy as applied in Röntgen-ray work for surgical purposes. It is of importance, in some cases, to take more than two stereoscopic pictures—three would probably be sufficient. An example illustrated is that of a skeleton hand and a cylindrical bar; when the bar is parallel to the line joining the eyes it does not appear from the stereoscopic picture whether the bar is behind the hand or in front of it. A description is given of a "symphanor," an instrument devised for measuring the depth of a foreign body from the surface, and of a "symphanator," for the simultaneous exposure with Röntgen rays and with ordinary light. A method is also given for obtaining the effect of depth and relief with monocular vision; the focus tube and eyepiece are connected so that by a pendulum movement they both move parallel to the screen while keeping at the same (equal) distance from it. By this method the distance of a foreign body from the screen may be measured by locating its "image" in front of the screen. G. E. A.

1034. *Electrochemistry of Light.* V. and VI. *Problem of Solarisation.* II. and III. **W. D. Bancroft.** (Journ. Phys. Chem. 13. pp. 181–250, March, and pp. 269–331, April, 1909.)—In these two papers the author concludes his summary of the literature of solarisation [see also Abstract No. 488 (1909)], from which the following general conclusions are drawn. The reversal of the photographic image is due primarily to a change in the silver salt, which is independent of the nature of the medium in which it is embedded; the readiness with which reversal takes place is, however, markedly dependent on the nature of the gelatine or collodion. It is much easier to obtain a reversal with a gelatine than with a collodion plate, and with a coarse-grained gelatine emulsion than with a fine-grained one; with pure silver bromide reversal is difficult. Reversal may be obtained by prolonged exposure, by the antagonistic action of light of different colours, by exposure to white light, followed by immersion in a solution of an oxidising agent and exposure to the spectrum, by the use of stained plates, by partial development and subsequent treatment with silver nitrate, by the action of white light during development, by very slow development of an under-exposed plate, by addition of thiocarbimide, &c., to the developer, by very short and intense exposures, with subsequent short exposure to diffused light, by kathode rays followed by sunlight, or by positive light of two intensities. The stronger the developer and the more prolonged the development, the easier is it to obtain a reversed image. Very slow development of an over-exposed plate will give a normal image. The latent reversed image is more readily destroyed than the latent normal image by bromine, nitric acid, ammonium persulphate, chromic acid, &c. With pure silver bromide collodion and chemical development, solarisation begins at approximately the same time as the visible blackening of the silver bromide, but with silver bromide collodion containing silver nitrate, visible blackening takes place long before any solarisation image is formed. The visible blackening of the plate which causes the second reversal is probably due to allotropic or metallic silver. Silver nitrate and potassium nitrate apparently prevent solarisation when added to the film before exposure; it is probable, however, that the rapid reduction to silver in presence of these halogen absorbers masks the solarisation. When a plate is exposed to light during development it makes no difference whether the light falls on the plate from above or below, so that there is no screening effect due to the partially developed image. In most cases there is a simple quantitative relation between the original exposure and the amount of light necessary during development if the plate is to be brought into the "zero state," but it is not known how far the form of the relation depends on any change in the colour-sensitiveness of the plate. The latent reversed image can be developed physically, and, if the plate is previously fixed, the image obtained may be normal or reversed, according to the conditions. In the developed plate the reversed image is mainly in the lower layers. According to Eder, there are three images—a latent normal, a latent reversed, and a normal silver image—on an undeveloped over-exposed plate; according to Homolka, there are two latent images. When a platinum electrode, coated with silver bromide, is dipped in a bromide solution and exposed to a moderate light it becomes the kathode; when a stronger light is used the Pt electrode will sometimes tend to become the anode. A film of silver iodide swells and clouds when exposed to light, but no measurable change in chemical composition takes place and the rate of clouding under the influence of light seems to be increased by the catalytic action of oxygen, iodine, &c. The substance forming the latent reversed image is a silver oxybromide of the general type AgBrO. According to Lüppo-Cramer, the latent reversed image consists of a reduction product of silver bromide, but, according to others, there is no such thing as a latent reversed image, the phenomena being due to the regeneration of silver bromide. The developable image consists of silver bromide and an α-silver sub-bromide which is itself reduced by the developer, but which acts as a catalytic agent, causing the developer to reduce the silver bromide; this α-silver sub-bromide can be reduced by light to a β-silver sub-bromide, which is also reduced by the developer, but has no catalytic properties. Solarisation occurs when the α-sub-bromide has been changed in the high lights very largely to the β-sub-bromide, and this change has not taken place to any great extent in the shadows.

T. H. P.

1035. *Photochemistry of Silver Sub-haloids.* **A. P. H. Trivelli.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 730–747, April 22, 1909.)—Traces out the successive formation, by the action of light, of sub-haloids from the normal haloid, which is not AgHal but $Ag_{2n}Hal_{2n}$, by removal of one atom Hal at a time. The successive sub-haloids differ in their absorption spectra and colour. With the decrease of the molecular weight of the silver sub-haloids the maximum of the absorption spectrum is shifted from red to violet; and all silver sub-haloids contain the group $Ag_{2n}Hal_n$, which behaves like a chromophore or contains one. The sensitiveness to light of the silver sub-haloids is due to electromagnetic light resonance; so is that of silver haloid. From AgBr we have successively a green, a blue, a red, and a yellow sub-haloid, so that $n = 4$ and bromide of silver is Ag_8Br_8. A. D.

1036. *Magnetic Dichroism of Minerals.* **G. Meslin.** (Comptes Rendus, 148. pp. 1179–1180, May 3, 1909.)—A further investigation on the magnetic dichroism of mixed liquids, in which a liquid is associated with a crystalline anisotropic mineral. Some thirty different minerals have been examined, mixed with water, methyl, ethyl, and amyl alcohols, acetic acid, petrol, turpentine, benzene, and carbon disulphide, and the birefringence of the minerals and dichroism of the liquors are tabulated, showing that as the birefringence becomes less intense the dichroism is more feeble. [See Abstract No. 228 (1909).] W. H. Si.

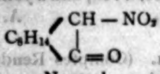
1037. *Polarisation by Lateral Diffusion.* **G. Meslin.** (Comptes Rendus, 148. pp. 1095–1097, April 26, 1909.)—A continuation of previous research on magnetic dichroism [see Abstract No. 228 (1909)]. A case of anomalous behaviour is described for liquors of which boric acid is a constituent. When such a liquor is left at rest until it becomes sufficiently clear, the ordinary effects of diffusion and polarisation, characterised by certain colours, are seen in the polariscope. When the liquid is agitated the appearance is at once modified, and there is a permutation of the tints observed. G. E. A

1038. *Relation between Absorption Spectra and Chemical Constitution. IX. The Nitroso- and Nitro-groups.* **E. C. C. Baly** and **C. H. Desch.** (Chem. Soc., Journ. 93. pp. 1747–1760, Oct., 1908.)—The absorption spectra of compounds (chiefly aliphatic) containing (NO) and (NO_2) groups have been examined. The results show that these groups give rise to definite selective absorption, the oscillation-frequency of which is remarkably low in the case of nitroso compounds. The nature of the atom to which the groups are directly linked exercises a great influence on the position of the absorption band. D. H. J.

1039. *Relation between Absorption Spectra and Chemical Constitution. X. Unsaturated Acids of the Benzene Series.* **E. C. C. Baly** and **K. Schaefer.** (Chem. Soc., Journ. 93. pp. 1808–1815, Nov., 1908.)—An examination of cinnamylidene acetic, cinnamylidene malonic, benzylidene malonic, and cinnamic acids and their metallic and alkyl derivatives. The second-named acid appears not to conform to modern views on colour, but the discrepancy is only apparent; the free acid is yellow, the colour being due to the absorption band with its head at 3,100: the sodium salt appears colourless to the eye since the absorption band is shifted just out of the visible region, but from the physical point of view it is almost as strongly coloured as the acid.

D. H. J.

1040. *Studies of Dynamic Isomerism. VIII. Relationship between Absorption Spectra and Isomeric Change. Absorption Spectra of Halogen, Nitro-, and Methyl Derivatives of Camphor.* **T. M. Lowry and C. H. Desch.** (Chem. Soc., Journ. 95. pp. 807–828, April, 1909.)—The absorption spectra of nitrocamphor and pseudo-nitrocamphor were examined with the view of finding whether the isomeric change from one of these isomers to the other exerts any definite selective absorption. No such absorption was found, but, on the other hand, the sodium salt of nitrocamphor exhibits a strong selective absorption. The authors suggest as the explanation of this, that the substance exists in the three forms—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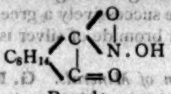
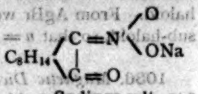

Pseudo.


Sodium salt.

The absorption spectra were also examined of camphor derivatives in which both the hydrogen atoms in the α position have been substituted by immobile atoms or groups. These compounds also show an absorption band, even though all possible enol-keto tautomerism seems to be excluded.

E. C. C. B.

1041. *Complex Structure of some Spectrum Lines of Mercury.* **H. Nagaoka.** (Mathematico-Physical Soc., Tōkyō, Proc. 5. 1. pp. 2–7, Jan., 1909.)—The observations were carried out with a 35-plate echelon, for which the resolving power for $\lambda = 5{,}000$ is 430,000 and the limit of resolution nearly 0·012. The two yellow lines and the green line were examined, and the components are given in detail in the paper. Among these the author has noted many not previously observed, the green line giving altogether 19 components. A striking feature in the case of the green line is the recurrence of constant differences between the wave-lengths of the components.

E. C. C. B.

1042. *Measurement of Small Displacements of Spectrum Lines.* **H. Buisson and C. Fabry.** (Comptes Rendus, 148. pp. 828–830, March 29, 1909.)—The authors have already described the results of their investigation of the differences of wave-length of iron lines in the solar and electric-arc spectra respectively [Abstract No. 786 (1909)]. They now describe their apparatus in detail. The interferometer plates are used either with an etalon of fixed distance, 2·5, 5, or 10 mm., or with graduated distances variable at will. A lens of 26 cm. focal length is used to project an image of the interference system on the spectroscope slit. For light sources giving very complicated radiations considerable dispersive power must be employed, and the authors used a Littrow grating spectroscope having a Rowland plane grating 568 lines to 1 mm., ruled surface 8 cm. × 5 cm., and a camera lens of 3·10 m. focal length. The third-order spectrum was usually employed, giving a dispersion of 0·58 mm. per Ångström unit. The observations consist of the measurement of differences of diam. of each ring as shown in each spectrum line. [See also Abstracts Nos. 1566 (1905), 1564 (1906).] C. P. B.

1043. *Secondary Spectrum of Hydrogen.* **C. F. Hogley.** (Phil. Mag. 17. pp. 581–583, April, 1909.)—A vacuum tube containing hydrogen under reduced pressure was connected with a bulb of charcoal immersed in liquid air. If the secondary spectrum were due to some impurity in the hydrogen this treatment would cause a fractionation of the two gases. No such effect was observed, and therefore the evidence is in favour of the secondary spectrum being due to hydrogen itself. E. C. C. B.

1044. *An Absolute Measurement of the Zeeman-effect as obtained with certain Mercury Lines in Weak Magnetic Fields.* **P. Gmelin.** (Ann. d. Physik, 28. 5. pp. 1079–1087, March 30, 1909. Extract from Dissertation, Tübingen.)—The author has measured the magnetic resolution of the Hg lines $\lambda = 5790$, 5769, 4916, and 4358, and determined the absolute value of $Z = (\Delta\lambda/\lambda^2 H)10^5$ for the Runge normal triplet. The mean value is 9·394, the extremes being 9·422 and 9·370, and the value of ϵ/μ obtained from this is $1{\cdot}771 \times 10^7$. E. C. C. B.

1045. *Zeeman-effect with the Lines of the Spectrum of Thorium.* **B. E. Moore.** (Phys. Zeitschr. 10. pp. 297–307, May 1, 1909. Translation.)—A complete investigation into the magnetic resolution of the lines of Th. Few complex types were observed showing six or more components. Some asymmetry in intensity as well as in position was noted in a few cases, and, moreover, some components were unsymmetrical as regards breadth. The general appearance of the broad component led the author to believe that they would be further resolved in a stronger field. [See next Abstract.] E. C. C. B.

1046. *Anomalous Zeeman-effects in the Thorium Spectrum.* **W. Ritz.** (Phys. Zeitschr. 10. pp. 307–308, May 1, 1909.)—Referring to some measurements in Moore's paper, the author points out that some anomalies are apparent. He has previously shown that on the scale of oscillation-frequencies the parallel components are given by $V = V_0 \pm m\omega$ and the perpendicular components by $V = V_0 \pm \omega' \pm n\omega$, where ω and ω' are characteristic constants and m and n whole numbers [see Abstract No. 914 (1908)]. Some deviations from this are to be found in the case of Th, as, for example, $\lambda = 3929{\cdot}74$, where the distance between the perpendicular components is just half that between the parallel ones. [See preceding Abstract.] E. C. C. B.

1047. *A New Type of Magnetic Resolution of the Absorption Bands of Crystals. Simultaneous Production of Systems circularly polarised in opposite Senses.* **J. Becquerel.** (Comptes Rendus, 148, pp. 913–915, April 5, 1909.)—A number of absorption bands, when observed in a magnetic field parallel to the optic axis, give doublets, the components of which are not entirely extinguished by the circular analyser. Dufour has observed the same in the emission spectra of the chlorides and fluorides of the alkaline earth metals, and has attributed the effect to an incomplete polarisation and called the remainder the residue of polarisation. The author now shows that these residues are due to new components distinct from the others and also polarised. In many cases the residues do not occupy the same position as the principal components of the doublet. E. C. C. B.

1048. *The Zeeman-effect with Tungsten and Molybdenum.* **R. Jack.** (Ann. d. Physik, 28. 5. pp. 1032–1056, March 30, 1909. Extract from Inaug.-Dissertation, Göttingen.)—A complete study of the Zeeman-effect with these two elements in a field of 24,650 gauss ; in order, however, to conform to

Paschen's measurements, the values have all been reduced to 28,850 gauss. Although the two elements belong to the same family, few similarities were noticed in the types of resolution of the lines having more than three components. Some very complex types were observed with W, and also a new series was found in the spectrum of this element. Several cases were found in the spectra of both elements which do not conform to the theory of Ritz [see Abstract No. 914 (1908); also No. 828 (1909)]. E. C. C. B.

1049. *Absorption of Röntgen Rays.* **C. G. Barkla** and **C. A. Sadler.** (Nature, 80. p. 37, March 11, 1909.)—A general summary is given of the simple laws relative to the absorption of Röntgen rays. Many elements when subject to a suitable Röntgen radiation emit at least one homogeneous beam of Röntgen radiation, characteristic simply of the substance emitting it. A radiation of more absorbable type than the radiation characteristic of a certain substance does not appreciably excite that characteristic secondary radiation. An incident radiation of more penetrating type excites the characteristic radiation of the exposed surface. The ratio of the absorption coefficients λ_A/λ_B in the case of two elements A and B is approximately a constant for any radiation which is not more penetrating than the radiation characteristic of A or B. When the incident radiation is of more penetrating type, the absorption is greater than would be given by this law. The intensity of secondary radiation increases with the general penetrating power of the incident radiation. The beam emerging from the absorbing plate consists of a weakened primary beam proceeding in its original direction, a little scattered radiation, and a homogeneous radiation uniformly distributed, except for internal absorption. In the case of Röntgen rays there is no evidence of any other kind of transformation. J. J. S.

1050. *Disturbing Action due to a Cylindrical Rod when introduced into a closed Space containing Radio-active Gases.* **J. Nabl.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 1127–1157, Oct. and Nov., 1908.)—This is a long mathematical paper dealing with the disturbing action which takes place when a cylindrical rod impenetrable to the radiations is introduced into a closed space containing a mixture of air and radio-active gases—*e.g.*, emanation. If R be taken to represent the range of the radiations emitted then it is found that the presence of the rod of radius δ causes the action of the active gases within a cylinder of radius $R + \delta$ to decrease from i to i', where—

$$i' = (1 - \omega_1'/\omega - \omega_2'/\omega)i.$$

ω_1'/ω is found to be $= \delta^2/(R + \delta)^2$, and ω_2'/ω may be taken as equal to $8\delta R/8(R + \delta)^2$ if δ is very small compared with R. Values for i' are calculated from the complete formulæ when $R = 4$ cm., and $\delta = 1$ cm. and 0·1 cm. respectively, and it is found in the first case that i' has a value about 90 per cent. that of i, while in the second case it reaches about 99 per cent. of that value. A. E. G.

1051. *The Rays of Uranium-X.* **F. Soddy.** (Nature, 80. pp. 37–38, March 11, 1909.)—A second series of observations [see Abstract No. 472 (1909)] have been carried out designed to detect the growth, if any, of a feeble α-radiation during the decay of the intense β-radiation of UrX. The appearance of α-radiation was indicated and the absorbable radiation very quickly reached a maximum, which then remained constant. About one-half the maximum was reached after 1 day, and after 2·5 days no further increase was observed. The absorbable radiation was about one-fifth the total. This α-radiation seems to remain constant for a period of years after the maximum is reached, and the observations made point to the existence of a new body presumably somewhere in the Ur series, with a period of the order of 1 day, the product of which gives α-rays and has a very long period of life. [See also Abstract No. 648 (1909).] J. J. S.

1052. *Volatility of Radium A and Radium C.* **W. Makower.** (Manchester Lit. and Phil. Soc., Mem. 53. 7. pp. 1–8, 1908–1909.)—The method used to determine the volatilisation point of RaA consists in exposing a nickel rod to a known quantity of Ra emanation for 10 min. at different temperatures and examining the nature of the deposit so collected on the rod, by observing its activity as measured by α-rays, and the rate of decay of this activity after removal from the emanation. If the rod is kept at a temperature above the volatilisation point of RaA none of that substance will be deposited. Apparatus is described for carrying out this experiment. Six curves are given, representing respectively the rate of decay of the activity collected when the rod is kept at 15°, 710°, 840°, 885°, 925°, and 990° C. From these it will appear that the volatilisation point of RaB is below 710°, and we may also infer that RaA begins to have an appreciable vapour-pressure at 800°, and that at 900° it is completely volatilised. In the case of RaC the experiments are undertaken not only to redetermine the volatilisation point, but also to investigate whether its environment has any influence on its volatility. The results obtained with Pt, Ni, and quartz plates are shown in a table. The volatilisation begins between 700° and 800°, but whereas with Pt and Ni it is complete at 1,200°, the volatilisation of RaC on a quartz surface is incomplete even at 1,300°. No certain change in the volatility of RaC is found after solution in HCl. Experiments described fail to reveal any charge in RaC at the moment of its production, and it may be inferred that it then acquires no charge. A. E. G.

1053. *Expulsion of Radio-active Matter in the Radium Transformations.* **S. Russ** and **W. Makower.** (Roy. Soc., Proc. Ser. A. 82. pp. 205–224, May 6, 1909.)—Some evidence has been brought forward by Miss Brooks to show that RaB can escape from a surface which has been exposed to the Ra emanation, which is therefore coated with a film of active deposit [see Abstract No. 2614 (1904). Rutherford has suggested that the RaB leaves the surface as the result of the recoil which takes place when it is formed from RaA by the expulsion of an α-particle. Hahn and Meitner have shown that the phenomena are even more marked when a negatively charged plate is suspended over the active surface ; they have also given some evidence of the projection of RaC into the gas surrounding a surface coated with the active deposit. Similar phenomena are described by them as occurring with actinium and thorium [Abstracts Nos. 474 and 649 (1909)]. The present paper contains details of further experiments, the principal results obtained from which are as follows : When Ra emanation in radio-active equilibrium with its products of disintegration is condensed at the bottom of an evacuated tube immersed in liquid air, active deposit particles are radiated up the tube. This phenomenon is ascribed to the recoil of the residual atom when an α-particle is emitted. The law of absorption of this radiation both in air and in hydrogen has been investigated. The radiation reaching a surface at a fixed distance from the condensed emanation is an exponential function of the gas pressure. In one experiment λ_{air}/λ_H is found to be 1·64, which indicates that hydrogen is much more efficient in absorbing this radiation than could be expected from its density. From the rate of decay of the activity collected on a surface exposed to the radiation from the emanation it appears that both RaA and RaB reach the surface. RaB and RaC are both radiated through a vacuum from a surface previously rendered active by exposure to the emanation. On the supposition that RaB emits only β-particles, the radiation of RaC must be due to the recoil of the atoms when β-particles are emitted. A. E. G.

1054. *α-Rays from Radium B.* **H. L. Bronson.** (Nature, 80. p. 159, April 8, 1909.)—Harvey has recently stated [Abstract No. 462 (1909)] that RaB gives out α-particles the ionisation range of which in air lies between 2·6 mm. and 8·0 mm. In his investigations he used a modification of the method of Bragg and Kleeman [Abstract No. 2061 (1905)], but on account of the limited range of the radiation he did not use a cone of rays. The author of the present paper has repeated Harvey's experiment, but has been unable to get any indication whatever of the presence of short-range α-particles. In addition, another method, based on the fact that the range of the α-particles is increased by reducing the pressure of the air, gave a null result; the ionisation in the testing vessel was found to be approximately proportional to the pressure of the air from 76 cm. to 8 cm., from which it is concluded that there were no α-particles present with a range in air of from 1 mm. to 5 mm. It is also pointed out that Harvey's reason for attributing the short-range α-particles to RaB is at fault. He assumes that after 140 min. RaB has practically disappeared, and that only RaC remains. The theory of radio-active transformations, however, requires that, after 140 min., the number of atoms of RaB and RaC changing per sec. shall be very nearly the same. A. W.

1055. *Differences in the Decay of Radium Emanation.* **E. Rutherford** and **Y. Tuomikoski.** (Manchester Lit. and Phil. Soc., Mem. 53. 12. pp. 1–2, 1908–1909.)—Determinations of the rate of decay of activity of Ra emanation have been made by various methods by a number of observers. The activity has been found to decrease exponentially with the time, falling to half value in 3·75 to 3·99 days. In the present experiments a large amount of emanation is enclosed in sealed tubes, and the decay of activity is measured by γ-rays. The rate of decay of the emanation is shown to be irregular, depending upon the treatment to which it has been subjected. It is found that samples which decay most rapidly are more easily absorbed in water, and more easily condensed by liquid air than the more slowly decaying fractions. No evidence is forthcoming that Ra produces two emanations, or that the products of transformation of the emanation of slow period are in any way different from those of the emanation of quick period. The results indicate that the emanation is a non-homogeneous chemical substance. It seems probable that the physical and chemical properties of the emanation atoms vary to some extent with the length of time after production before disintegration, and that these atoms undergo a progressive change in properties before disintegration. Experiments are in progress to test the correctness of this view. A. E. G.

1056. *Emanation of Radium.* **A. Debierne.** (Comptes Rendus, 148. pp. 1264–1267, May 10, 1909.)—These experiments are undertaken to investigate the properties of the emanation of Ra when in a concentrated form.

Previously obtained results of Rutherford and Royds are confirmed. The volume occupied by the emanation in equilibrium with 1 gm. of Ra is found, as the result of a series of observations, to be 0·58 mm.^{3}. The curves [not given in the paper] illustrating the decrease of the intensity of the radiation emitted by different gaseous portions are determined. The portions which condense more easily give very concordant results, diminishing to half value in 3·81 days. The small part which is mixed with He and which does not condense requires 4·1 days for the value to decay to one-half [see also preceding Abstract]. During the experiments it was noticed that the small tubes containing the emanation at atmospheric pressure are the seat of spontaneous electric discharges, visible in full daylight. These discharges in some tubes take place as frequently as once per min., and present the appearance of very fine sparks. They are produced only with certain kinds of glass, that which presents the phenomena most frequently being a fusible lead glass. This is attributed to the accumulation in the glass of electric charges of rays emitted by the emanation. A. E. G.

1057. *Thermal and Ionising Action of Thorium Present in Rocks.* **G. A. Blanc.** (Accad. Lincei, Atti, 18. pp. 289–294, March 21, 1909.)—Calculating from Pegram and Webb's results [Abstract No. 1436 (1908)], 1 gm. of thorium, in radio-active equilibrium, develops $2{\cdot}88 \times 10^{-5}$ gm.-cal. per hour, whence the heat produced in various minerals containing known amounts of thorium [see Abstract No. 887 (1909)] is deduced per gm. of material, two specimens of sienite giving $19{\cdot}7 \times 10^{-10}$ and $15{\cdot}0 \times 10^{-10}$ gm.-cal. per hour respectively, an Italian granite $7{\cdot}47 \times 10^{-10}$, French granite $4{\cdot}93 \times 10^{-10}$, and a sample of arable earth at Rome (containing $1{\cdot}45 \times 10^{-5}$ gm. Th per gm.) $3{\cdot}45 \times 10^{-10}$ gm.-cal. per hour, the average for all being $1{\cdot}01 \times 10^{-9}$ gm.-cal. per hour per gm. of material. This is about double the heat generated in radium minerals, which, calculated from the results of Strutt and Rutherford, in radio-active equilibrium with all the members of the family up to RaF (polonium), is $5{\cdot}5 \times 10^{-10}$ gm.-cal. per hour. Since the α-radiation is proportional to the heat produced the ionisation due to α-rays from Th should be double that due to α-rays from radium. The β-rays have only feeble ionising power, and, based on Eve's results as to the relative γ-activities of Ra and Th [see Abstract No. 258 (1907)], the intensity of the γ-radiation emitted by Th minerals is 5·7 times greater than that from radium-containing igneous rocks. The discrepancy between the amounts of Ra in the soil at Montreal calculated by Eve by two different methods [Abstracts Nos. 1866 (1906) and 71 (1908)] is attributed to the presence of Th in the soil, which may have vitiated the first result. W. H. St.

1058. *Distribution of Thorium in the Earth's Surface Materials.* **J. Joly.** (Phil. Mag. 17. pp. 760–765, May, 1909.)—Recent observations have shown that the emanation of Th exists in the atmosphere to an extent which is difficult to explain unless a very considerable quantity of Th is distributed in the surface rocks and soils. Thus Blanc estimates that at Rome from 50 to 70 per cent. of the whole activity is due to Th [Abstract No. 888 (1907)], and Wilson infers from his observations at Manchester that there is about seven times as much Th as Ur in the surface soil [Abstract No. 475 (1909)]. On the other hand, Gockel finds at Zermatt that the emanation of Th is almost entirely absent. The present paper, in which the Th-content of various rocks is investigated and the method of so doing described, claims to be only of a preliminary nature, but the following results are worthy of note. Every rock examined, with three exceptions, is found to contain Th. The quantities observed in some cases are such as might afford an explanation of the local occurrence of Th emanation in the atmosphere, although the general average of the few rocks examined is hardly such as to account for a general prevalence of the emanation to the extent to which it has been observed in some localities, unless Th disintegrates faster than is generally assumed. It may be, however, that surface soils are richer in Th than the rocks from which they are derived. Confirmatory evidence in favour of Blanc's results is found when Vesuvian lavas are examined. The amount of Th in sea water is small, and until observations are made on a large quantity of water only negative results are obtained. A Th salt added to sea water gives an immediate precipitate. It may be that the poverty in Th of the oceanic waters, and the underlying sediment, is not a true indication of the Th-content of the rocks, but is to be referred to chemical effects consigning the Th to the littoral deposits. Should Th be breaking up, as Bragg states at one-fifth the rate of Ur, then, taking into account the lesser emission of α-particles by the derivatives of Th, the results obtained indicate that a relatively unimportant place must be assigned to Th compared with Ur as a heat-producing agent in the rocks. On the other hand, if the rates of transformation are about equal, as found by Soddy, the importance of Th might be comparable with that of Ur, the quantities of the two elements in rocks not appearing to differ greatly. A. E. G.

1059. *Direct Estimate of Minimum Age of Thorianite.* **R. J. Strutt.** (Nature, 80. p. 308, May 18, 1909.)—An experiment affording more direct proof of the great antiquity of radio-active minerals than anything previously attempted is here recorded. The principle of the method is to determine (1) the total quantity of accumulated He in the mineral; (2) the rate of formation in the *same* material at present. A sample of thorianite is found to contain 9 c.cm. He per gm. The annual rate of production of He is found to be less than $8{\cdot}7 \times 10^{-8}$ c.cm. per gm. The 9 c.cm. initially present cannot therefore have accumulated in a less time than 240 million years. No uncertainty arises on the ground that the substance may formerly have contained much more Ur or Th than at present, for thorianite consists almost entirely of the oxides of these elements. Experiments on a large scale are in progress. A. E. G.

1060. *Leakage of Helium from Radio-active Minerals.* **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 82. pp. 166–169, May 6, 1909. Chem. News, 99. pp. 145–146, March 26, 1909.)—In some previous experiments the author has found that the quantity of He contained in the geologically older materials is not uniformly greater than in the younger ones of equal activity. This was hypothetically attributed to the escape of He in some cases. The present experiments are undertaken to, if possible, obtain confirmation of this theory. Ores of Ur and Th are used in quantities of 1 kg. or more. The method of carrying out the experiments is described. It is found that after a radioactive mineral has been powdered He is evolved from it, rapidly at first, then at a diminishing rate. Since the majority of radio-active materials can only be obtained in the form of pieces which have been broken off from their natural home some years ago any observations made upon them are inconclusive as to the rate at which He escapes when they are undisturbed in their natural surroundings. With a view to testing a mineral more nearly in its natural conditions, experiments are carried out on thorianite which occurs in gravels in detached cubic crystals. This, too, showed a considerable leakage of He, and the rate of escape of He is found to be uniform. It is next tested after being kept in a bottle surrounded by ice for some days; the leakage is now less, but still greatly in excess of the rate of accumulation. These experiments having been arranged so that the mineral evolving He is in a vacuum, it is next tested whether a change in the rate of escape can be brought about by filling the bottle containing the mineral with oxygen at atmospheric pressure: no such change is noted. It is, however, thought that it is highly probable that loss of He occurs from the weathering of interior surfaces as well as from the external faces of the crystals. Abrasion of the external surfaces by comparatively recent rolling in watercourses may have produced some effect. The conditions under which the life of the minerals has been mainly passed must be supposed more favourable for the retention of He than laboratory conditions, for otherwise the present accumulation could never have been formed. A. E. G.

REFERENCES.

1061. *Testing of Paraboloidal Mirrors.* **C. D. P. Davies.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 355–382, March, 1909.)—The author gives a connected account of the best-known methods of figuring a parabolic telescope mirror. An appendix by H. C. Plummer gives the derivation of Draper's formula for the longitudinal aberration of a paraboloid at the centre of curvature. C. P. B.

1062. *Theory of Dispersion and Extinction of Light in Luminous Gases and Vapours.* **J. Laub.** (Ann. d. Physik, 29. 1. pp. 94–110, April 22, 1909.)—A mathematical discussion on the electron theory of the above phenomena. E. H. B.

1063. *A Comparison of the Radium Emanation Spectra obtained by different Observers.* **T. Royds.** (Roy. Soc., Proc. Ser. A. 82. pp. 22–25, Feb. 16, 1909.)—It is pointed out that Ramsay and Cameron's measurements of the spectrum of radium emanation [Abstract No. 1793 (1908)] contained a number of lines due to xenon. [See also Abstract No. 1415 (1908).] E. C. C. B.

HEAT.

1064. *Melting-point of Platinum.* **C. W. Waidner** and **G. K. Burgess.** (Comptes Rendus, 148. pp. 1177–1179, May 3, 1909.)—The results of Féry and Chéneveau [Abstract No. 656 (1909)] are considered unreliable, being obtained by extrapolation, using an empirical formula. From determinations by monochromatic radiation the authors find the melting-point of Pt to be 1,770° [see also Abstract No. 1862 (1907)]. W. H. Si.

1065. *Specific Heats of Liquids which become Solid at very Low Temperatures.* **A. Battelli.** (Journ. de Physique, 7. pp. 881–889, Nov., 1908.)—The cooled liquid was placed in a Dewar vacuum vessel which served as a calorimeter. The liquid was heated electrically by a spiral of wire coiled in it; the number of units of heat communicated to the liquid was calculated according to Joule's law. The following liquids were studied: ether (from −2°·81 to −91°·37); toluene (from −25° to −92°·02); ethylene bromide (−28°·82 to −105°·47); petroleum ether (down to −161°·2); ethyl alcohol (−27°·97 to −90°·7); amyl alcohol (−9°·55 to −49°·45); carbon bisulphide (−0°·09 to −95°·75). The curves expressing the results tend to become at the lowest temperatures, asymptotic to a parallel to the temperature axis.
D. H. J.

1066. *Radiation and Temperature of the Bunsen Flame.* **E. Bauer.** (Comptes Rendus, 148. pp. 908–910, April 5, 1909.)—The Bunsen flame, and indeed every flame containing water-vapour, possesses marked absorptive and emissive power for the residual rays of fluorite ($\lambda = 25{\cdot}5\,\mu$). By comparison of the ratio between the two, the mean temperature of the flame is found to be 1,760° ± 50°. As neither the emissive nor the absorptive power is changed by rendering the flame coloured with salt vapours, so the temperature is not altered. A determination of the reversal of the D lines in the flame gives the temperature as about 1,755°, which agrees well with the previous measurements. Further, the author has measured the temperature of the various regions of the flame by the reversal of the D lines, and the curve he obtained agrees very strikingly with that of Schmidt. E. C. C. B.

1067. *Radiation and Temperature of the Hefner Lamp.* **A. Becker.** (Ann. d. Physik, 28. 5. pp. 1017–1031, March 30, 1909. Physikal. Inst. d. Univ., Heidelberg, Jan. 27, 1909.)—The first part of the paper is concerned with observations of the absorption of the Hefner flame over the range 500–700 $\mu\mu$. Light from a Nernst lamp is, by a combination of three lenses, split into two parallel beams which by means of a system of total reflection prisms are directed on to the slits of a spectrum photometer. One beam serves as a standard, and is compared with the other by itself and also when passing through the flame. From these two measurements together with the determination of the radiation of the flame itself the absorption of the flame can be calculated. The same apparatus is next used to determine the power of absorption for different wave-lengths of soot when deposited on a thin glass plate. The soot was obtained chiefly from the amylacetate flame, but in some cases turpentine soot was used. In the region 480–700 $\mu\mu$ the absorption-curves for the two kinds of soot were practically coincident but differed considerably from the results obtained by Stark for gas soot. On the assumption that the law of absorption of light in passing through the flame is the same as that in passing through a layer of soot, it is found that the former results may be brought into exact coincidence with the latter if they are multiplied by a certain factor. Thus the relative course of the absorption is the same in both cases, being independent of the difference in condition of the carbon particles. In the last portion of the paper the author considers the temperature of the Hefner flame, and from his observations concludes that the glowing carbon particles in the flame have a temperature of 1,670° abs. W. C. S. P.

1068. *Pressure of Saturated Mercury Vapour for 0° C. and Higher Temperatures.* **M. Knudsen.** (Ann. d. Physik, 29. 1. pp. 179–193, April 22, 1909.)—The weight of gas of density ρ_1 which flows through an orifice under a pressure-difference $p' - p''$ in time τ is given by—

$$G = \sqrt{\rho_1}(p' - p'')\tau/(W_1 + W_2);$$

here W_1 and W_2 are constants depending on the dimensions of the orifice and of the tube through which the gas flows, also the density is measured at a pressure of 1 dyne/cm.² [see Abstract No. 975 (1909)]. The author has made use of this result to obtain the vapour pressure of mercury. A wide vertical glass tube, 20–30 cm. in length, is attached at its lower extremity to a narrow calibrated tube capable of holding about 1·5 gm. of mercury. The upper end of the tube is closed and is blown out until the glass is very thin; it is also fused into a larger bulb which can be put in communication with an air-pump. Pure dry mercury is placed in the space between these two bulbs. The whole apparatus having been evacuated, the upper part is put in melting ice, and the lower part, consisting of the calibrated tube, put into a Dewar flask containing a mixture of CO_2, snow and benzol. Mercury vapour will then pass through a fine hole which has been made in the thin glass bulb, and will condense in drops in the calibrated tube. By determining the time taken for a certain weight of mercury to condense it is possible to calculate the pressure-difference between the vapour at the two extremities of the apparatus. The author takes this difference as being a measure of the vapour pressure of the mercury at the higher temperature. The paper concludes with a table of the logarithms of the vapour pressure of mercury for every 10° between −50° and +390° C. W. C. S. P.

1069. *Relation between Mean Free Path of Gas Molecules and the Refractive Index of the Gas.* **H. Sirk.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 1159–1164, Oct. and Nov., 1908.)—The absolute number of molecules per mm.³ of a gas is given by the expression, $N = 1/320\ L^3x^2$, L representing the mean free path and x the fraction of the volume actually occupied by the molecules. Since, according to Avogadro's law, N must be approximately the same for all gases under equal conditions of temperature and pressure, L^3x^2 must also have the same value for all gases. Exner (Ibid. 91. 2. p. 850, 1885) showed that these magnitudes can be calculated from the refractive indices with the help of the theory of Clausius and Mosotti on the constitution of dielectrics which gives the formula $x = (K-1)/(K+2)$ in which K represents the dielectric constant. According to Maxwell, $K = n^2$, so that the expression becomes $x = (n^2-1)/(n^2+2)$. But since, for gases, n is always nearly unity, the formula $x = 2(n-1)/3$ holds very approximately. L^3x^2 being the same for different gases under similar external conditions, $\mathrm{L}^{1\cdot5}x$ is also constant, and the same is the case with $\mathrm{L}^{1\cdot5}(n-1)$. Investigation of the value of $\mathrm{L}^{1\cdot5}(n-1)$ for 32 different gases shows that this expression is much more nearly constant than the empirical formula $\mathrm{L}(n-1)$. Further, the variations of the calculated values of the former expression are irregular, whilst those of the latter diminish appreciably with increase of wave-length. Hence, the values of x, that is, under similar external conditions, the magnitudes of the various molecules, determine the mean free paths as well as the refractive indices of the gases. T. H. P.

1070. *Determination of the Constant of Stefan's Law.* **C. Féry.** (Comptes Rendus, 148. pp. 915–918, April 5, 1909.)—The author has made a determination of the radiation constant using a conical copper receiver the interior of which was covered with smoke-black. [See also Abstract No. 861 (1909).] In order to standardise the apparatus in watts the exterior of the cone was wired with manganin. The receiver, protected by a sheath of polished German silver, was supported at the centre of a metallic sphere by constantan wires, a galvanometer being connected between the sphere and the receiver. The source of radiation was an electric furnace provided with a circular aperture and a water-cooled metal screen; the temperature of the furnace was measured by means of a thermo-couple. In the calibration of the receiver it was found that the deflections of the galvanometer were accurately proportional to the watts supplied up to 0·1 watt, showing that losses by convection and radiation may be entirely neglected in comparison with that by conduction. Working between the temperatures 529° and 1,268° the author finds that the mean value of the radiation constant is $6{\cdot}30 \times 10^{-12}$ watt/cm.². This is probably correct to 2 per cent., there being very good agreement of the results over the whole range of temperatures. W. C. S. P.

1071. *Some Consequences of employing a Selective Receiver in the Measurement of Radiation.* **C. Féry.** (Comptes Rendus, 148. pp. 1043–1044, April 19, 1909.)—Two metallic plates are suspended vertically by silk threads, and are connected at their centres by a fine constantan wire. Copper wires are also attached to the plates so that the combination forms a thermo-electric couple. The one plate is plane and the other corrugated, and they are both blackened with the substance to be studied. When exposed to radiation the corrugated plate will act approximately as a full receiver for the side receiving the radiation, and on the other face as a full radiator. If the plane surface is covered with smoke-black it is found to take up a higher temperature than the other when exposed to radiation from any source at a temperature higher than the surroundings. Platinum black has a minimum coefficient of absorption at about 6 μ; hence for a source at about 500° C. giving this wave-length the plane surface is the cooler. For sources at temperatures either above 1,000° or below that of the surroundings the plane surface is the hotter. Thus the use of a selective receiver will cause a deformation of the curve of energy distribution in a spectrum. [See also Abstract No. 861 (1909).] W. C. S. P.

1072. *Statistical Form of the Curve of Oscillation for Radiation emitted by a Black Body.* **H. A. Wilson.** (Roy. Soc., Proc. Ser. A. 82. pp. 177–181, May 6, 1909.)—The author adopts the view that the radiation from a black body is an irregular disturbance subject to statistical laws, and shows how these laws can be deduced from the observed distribution of energy in the spectrum. In any part of a spectrum the radiation may be regarded as the sum of a number of simple vibrations. The component vibrations may be regarded as continually varying, but the distribution of energy in the spectrum when averaged over a short interval remains constant. If we compound a large number n of simple harmonic vibrations all along the same line each having amplitude a, then the chance that the displacement at any instant selected at random will lie between the limits y and $y + dy$ is $a^{-1}(\pi n)^{-\frac{1}{2}}e^{-y^2/na^2}dy$. Starting with this result the case of plane-polarised radiation is considered and the statistical properties are determined. For further information concerning the mathematical treatment the original should be consulted. W. C. S. P.

1073. *Heat Given off by Radio-active Bodies.* **W. Duane.** (Comptes Rendus, 148. pp. 1448–1451, June 1, 1909.)—An apparatus is described with diagrams, by means of which it is possible to show with certainty a heat production in quantities of 1/1000 gm.-cal. per hour, and the experiment requires only a few minutes. The method is based upon the rapid increase of vapour tension of a very volatile liquid (sulphuric ether is used) as the temperature rises. Two glass vessels, A and $A_{\prime\prime}$, are connected by a capillary tube B, and each is partly filled with the volatile liquid. Some of the air is removed by a water pump and the tube sealed up. A small bubble of air is placed in the tube B, and the displacement of this bubble is used as an indication of the amount of heat set free in one of the vessels. Reasons are given why this method is very sensitive, and also details as to the way in which the whole apparatus is protected from heat due to external sources. Another method is also employed in which the heat is absorbed as it is given out. In the tube containing the radio-active material an iron-nickel couple is placed, and it is known that the intensity of the current passing through this is a measure of the heat absorbed per sec., providing the current does not exceed a given limit. To check the results the heat given out by 0·80 mgm. of $RaCl_2$ is investigated, and it is found to be equivalent to 120 gm.-cals. per hour for each gm. of Ra present. Radiothorium is then examined, and the amount of heat liberated is found to be of the same order as that given out by Ra. A salt containing polonium free from Ra and radiothorium is also found to give out heat. A. E. G.

REFERENCES.

1074. *Coefficients of Expansion of Gases.* **A. Leduc.** (Comptes Rendus, 148. pp. 1173–1176, May 3, 1909.)—An improved knowledge of molecular volumes has enabled the coefficients of expansion under constant pressure and of increase of pressure at constant volume to be calculated with greater accuracy. The mean coefficients between 0° and 100° C., and the true coefficients, are given for all the commoner gases. W. H. Sr.

1075. *On Energy Accelerations and Partition of Energy.* **C. W. Follett.** (Roy. Soc. Edinburgh, Proc. 29. pp. 349–375, 1908–1909.)—An extension of Peddie's work [Abstracts Nos. 84 and 1654 (1908)] to the case of two particles moving in a field of force and under the influence of their own attraction. Mathematical. L. H. W.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1076. *Direct Application of Electron Theory to Induction Currents.* **R. J. A. Barnard.** (Phil. Mag. 17. pp. 706–710, May, 1909.)—If a conductor is moved bodily in a magnetic field the motion of the positive and negative electrons so produced will cause component electromagnetic forces to act which will drive the positive electrons in one direction and the negative in the other, thus producing the induction current. Dynamical laws are applied to the motion of the electrons to find the e.m.f. of induction, and it is also shown that the equation: $\operatorname{curl} E = -d\beta/dt$ leads to the same result. This equation and $\operatorname{curl} H = 4\pi C$ are deducible from one another on the electron theory with the help of the experimental facts of relative motion with respect to induction currents. G. E. A.

1077. *Frictional Electricity.* **M. Owen.** (Phil. Mag. 17. pp. 457–465, April, 1909.)—A description is here given of experiments made with the object of determining the intensity of the electrification produced by friction under various conditions as to the nature, pressure, and velocity of the rubbing surfaces. The results indicate that in each case the surface (if insulating) acquires, after a sufficient amount of friction, a constant surface-density which is independent of the pressure applied during the friction. The specimens rubbed were of ebonite and glass, and curves are given showing the charge produced by different amounts of frictional work.

A. W.

1078. *The Electricity of Rain and its Origin in Thunderstorms.* **G. C. Simpson.** (Roy. Soc., Proc. Ser. A. 82. pp. 169–172, May 6, 1909. Abstract.) —At the Meteorological Office of the Government of India a systematic record has been kept by means of autographic instruments of the amount of electricity brought down by rain. A total rainfall of 76·8 cm. yielded 22·8 electrostatic units of positive electricity per cm.^{3} and 7·6 units of negative. During 71 per cent. of the time that charged rain fell, the charge was positive. In 7 storms the recorded charge exceeded 6 units per cm.^{3}, and in 2 the negative charge exceeded this value. Regarding charged rain as equivalent to a current from air to earth, the current strength exceeded 300×10^{-15} amp. per cm.^{2} in 6 positive storms and in 2 negative storms. The heavier the rain, the more did positive electricity predominate. Light rain was more strongly charged than heavy rain. The proportion of negative electricity brought down was slightly greater in the second half of a storm than in the first. Laboratory experiments show that when a drop of water is broken up into small drops in the air, the water becomes positively electrified and the air negatively. Drops having a volume of 0·24 cm.^{3} fell on a vertical jet of air which broke them into small drops. The water from each drop after breaking was found to have a charge of $5{\cdot}2 \times 10^{-3}$ electrostatic unit of positive electricity. In further experiments the air in which the drops had been broken was tested in an Ebert apparatus, and was found to contain $8{\cdot}3 \times 10^{-3}$ electrostatic units of free negative ions and $1{\cdot}1 \times 10^{-3}$

of positive ions, the excess corresponding with the positive charge retained by the water. Drops having a greater diameter than 5·5 mm. are unstable when falling through air and break up into smaller drops. Also drops of smaller diameter than 5·5 mm. have a final velocity when falling through still air of less than 8 m./sec. (Lenard, Meteorolog. Zeitschr. 21. p. 249, 1904). Thus no water can fall through an ascending air current of vertical velocity exceeding 8 m./sec. It is exceedingly probable that currents of this vertical velocity occur in thunderstorms. At the top of the current there will be an accumulation of water in which the drops are continually going through a process of being broken up and growing again to the critical size of breaking. There will thus be a continuous separation of electricity in progress. The air carries away negative ions but leaves positively charged water behind. When this water finally reaches the ground, it does so as positive rain. The negative ions which travel along with the air are rapidly absorbed by the cloud particles, and in time the cloud may become strongly negatively charged. Now in a highly charged cloud there must be rapid combination of drops; these fall ultimately as negatively charged rain. A rough quantitative analysis of the order of magnitude of the electrical separation shows that it is sufficient to account for the electrical effects in the most violent thunderstorms. R. G. K. L.

DISCHARGE AND OSCILLATIONS.

1079. *Energy of Electron Emission of Glowing Bodies.* **A. Wehnelt** and **F. Jentzsch.** (Ann. d. Physik, 28. 3. pp. 537–552, March 2, 1909. Physikal. Inst. d. Univ., Berlin, Dec., 1908.)—When metals, metallic oxides, or carbon are heated in a vacuum negative electrons are sent out, and O. W. Richardson [Abstract No. 1489 (1904)] has given an equation which expresses the relation between the temperature and the number of the emitted electrons on the assumption that the electrons in the interior of a metal follow the Boltzmann-Maxwell law of the distribution of velocity in the same manner as the molecules of a gas. This equation is $N = n\sqrt{}/(R2\pi m)\sqrt{T}\,.\,\epsilon^{-\Phi/RT}$, where N is the number of electrons emitted per unit of surface area, n the number of the same in unit volume of the substance, T the absolute temperature, m the mass and R the gas constant for an electron, whilst Φ signifies the work which an electron must do on penetrating the surface and escaping. On multiplying both sides of the equation by ϵ the result J or $N\epsilon$ = the saturation current of the electrons per unit of surface. Richardson gives for the value of U, the total energy withdrawn from glowing bodies by the escaping electrons, the equation $U = n(1 + \Phi/2RT)\sqrt{(2R^3T^3/\pi m)}\epsilon^{-\Phi/RT}$ and $V = N(\Phi + 2RT)$. Richardson calculated that at a temperature of a little over 2,000° the radiation energy is already equal to that of a black body, and that at higher temperatures this radiation energy considerably surpasses, and also increases more quickly than, the latter. It follows that the loss of energy of a heated body in an electron field must depend upon the direction of the field. The increase of energy which is necessary to maintain a body at constant temperature if it emits electrons has been *qualitatively* determined. The object of the author of the present paper was to subject the theory of Richardson to *quantitative* proof if possible. If a heated body, *e.g.*, a Pt wire or carbon filament, is kept in a vacuum the energy required to keep its temperature constant is determined by the loss due to conduction and radiation. If J is the current required to heat the wire, and $W_{(T)}$ the resistance at temperature

T then $E = J^2 W_{(T)}$, when $E =$ the energy required per sec. to maintain T constant. When placed in an an electric field $U = W_{(T)}(J_2^2 - J_1^2)$, when J_1 and J_2 signifies the currents necessary for heating the wire with and without electron emission. Since $W_{(T)}$ J_1 and J_2 are measureable U may be calculated. Details of the methods of measurement and of the results obtained are given in the paper, but considerable difficulties stand in the way of carrying out accurate measurements, and the quantitative agreement of the results of observation with theory are not satisfactory. The theory must be regarded as not yet fully established. [See next Abstract.] J. J. S.

1080. *Energy of Electron Emission.* **A. Wehnelt** and **F. Jentzsch.** (Deutsch. Phys. Gesell., Verh. 11. 5. pp. 105–108, March 15, 1909. Physikal. Inst. d. Univ., Berlin, Feb., 1909.)—When carbon, metal, or metallic oxides are heated in a vacuum they emit negative electrons which, by means of an electric field of suitable direction and strength, can be removed from the hot bodies. The escaping electrons carry away an amount of energy which is expressed by the equation $U = N(\Phi + 2RT)$ [see preceding Abstract]. Through this removal of energy the heated bodies are cooled, and to keep them at a constant temperature more energy must be given to them than if no electrons escaped. The energy of electron emission has been previously observed in a qualitative way by the authors, and in the present paper they give a short account of quantitative determinations of the energy. The electron-emitting body consisted of a Pt wire covered with CaO, fixed in the axis of a metal cylinder. Wire and cylinder were placed in the midst of a glass vessel in which was a high vacuum, and between them a suitable p.d. was maintained. The wire formed a branch of a very sensitive Wheatstone bridge arrangement. The current strength due to heating of the wire—the "heat current strength"—was balanced by compensation. The energy of electron emission, $U = W_{(T)}(J_2^2 - J_1^2)$ [*loc. cit.*]. When J_1 and J_2 differ but little the equation may be written $U = W_{(T)}2J(\Delta J)$. $J_1 =$ the heat current strength without, and J_2 the same with electron emission. The values of ΔJ have been calculated and also observed. The ratios of the two—the observed and calculated values—are given in a table. This ratio varies considerably, the observed values being the greater, and the ratio varying from 7·06 to 1·5. The ratio decreases as the temperature is raised to 1,200° C.

J. J. S.

1081. *Photo-electric Fatigue of Zinc.* **H. S. Allen.** (Roy. Soc., Proc. Ser. A. 82. pp. 160–164, May 6, 1909.)—The author has shown that when zinc is exposed to the light of a Nernst lamp the photo-electric activity at a time t from the commencement of an experiment could be represented by the formula $I = K_1 e^{-\lambda_1 t} + K_2 e^{-\lambda_2 t}$ [Abstract No. 704 (1907)]. The experiments now described are carried out in order to determine whether the results are similar when using a source of light giving far more ultra-violet radiation than the Nernst lamp. A Heraeus mercury-vapour lamp of fused quartz supplied with current by a battery of 50 accumulators is employed for this purpose. The photo-electric activity of a Zn plate is again found to decay in such a way that its activity can be represented as the sum of two exponential terms. The constants of change are but little altered by considerable variations in the character and intensity of the illumination employed, though the value of the photo-electric current is changed considerably. The rate at which the surface is altered is not greatly affected by using a mercury-vapour lamp in place of a Nernst lamp. Experiments with other metals are still in progress. A. E. G.

1082. *Rotation of the Electric Arc in a Radial Magnetic Field.* **J. Nicol.** (Roy. Soc., Proc. Ser. A. 82. pp. 29–42, Feb. 16, 1909.)—An account is given of a series of measurements of the velocity of motion of an electric arc in a magnetic field at right angles to its length. The experiments were similar to those made by H. A. Wilson and G. H. Martyn with the electric discharge in a vacuum tube. [Abstract No. 1672 (1907).] The speed of the electric arc across the transverse magnetic field was found to be (1) independent of the arc-length; (2) proportional to the strength of the magnetic field; and (3) to increase linearly with the current. From the results of the experiments the value of the product of the speeds of the ions carrying the current was calculated; and from this value, by assuming the negative ion to be a corpuscle and calculating its velocity, it is deduced that the carriers of positive electricity have a mass of the same order of magnitude as that of the hydrogen atom. J. J. S.

1083. *The Relighting of the Carbon Arc.* **J. A. Pollock, E. M. Wellisch and A. B. B. Ranclaud.** (Phil. Mag. 17. pp. 449–456, April, 1909. Paper read before the Royal Soc. of New South Wales.)—When the arc between fixed carbons in a hand-fed lamp goes out it may be restarted by bringing the carbons nearer one another but without touching, provided that this be done quickly enough. Upson [see Abstract No. 1555 (1907)] has carried out an extensive series of experiments on this phenomenon. It is pointed out, however, that the relighting of the arc after a given time of interruption depends not only on the previous current, but also on the p.d. established between the electrodes at the moment of reclosing the circuit. The object of the experiments was to find the relation between the latter factor and the perfectly determinate time-interval. The problem is that of the change from a non-luminous to a luminous charge in air at normal pressure. An explanation of this in the case where negative electricity flows from a hot to a cool carbon has been given in a previous paper. In the present experiments both carbons are at a high temperature, and the conditions of the change are complicated by the presence, at the moment of reclosing the circuit, of ions at the anode surface as well as near that of the kathode. In some of the cases examined the relations show a critical characteristic, but sufficient data are not available to enable an explanation of this phenomenon to be given. A. R.

1084. *Magnetic Rays.* **A. Righi.** (N. Cimento, 17. pp. 5–11, Jan.-Feb., 1909.)—The author describes a number of experiments which support his view as to the existence of "magnetic rays," formed by combination of positive atoms and electrons [see Abstracts Nos. 952 (1908) and 297 (1909)]. The rays are found in the transformation products of secondary kathode rays or of kathode rays issuing from the constricted region of a narrow-necked tube, and in the recombinations of ions and electrons formed by the splitting up of other magnetic rays by impact with an obstacle. In oxygen, and under certain pressures, magnetic rays produce a phosphorescence on the walls of the tube. W. H. St.

1085. *Observations on Canal Rays.* **J. Stark and W. Steubing.** (Ann. d. Physik, 28. 5. pp. 974–998, March 30, 1909.)—The experimental details of some work of which the results and theoretical bearing have already been published [see Abstract No. 119 (1909)] are given. A plane Rowland grating is employed, and different makes of photographic plates are used for the different hydrogen lines. The methods of intensifying the negatives and correcting for under-exposure, and the allowance for the shift in the band in observing the Doppler-effect in the canal rays due to this cause, and to halation are explained. From the velocities of the ions as calculated from the first and second displacement lines it is found that the square of the ratio of the velocity of the second to that of the first is approximately 2. The ratio of kinetic energy to work done in the kathode dark space is also estimated, and it is found that this falls in a particular case from 0·907 with a kathodic p.d. of 890 volts, to 0·274 for a kathodic p.d. of 7,000 volts. Similar estimates are made for the reflected rays; the variation in this case is rather greater. S. G. S.

1086. *Action of Visible and Ultra-violet Light on Negative Glow.* **W. Rudolph.** (Ann d. Physik, 29. 1. pp. 111–124, April 22, 1909. Physikal. Inst. d. Univ., Leipzig, Feb., 1909.)—Experiments are described in which the action of light upon a kathode-glow oscillograph similar to that used by Gehrcke [see Abstract No. 2100 (1905)] is investigated. Various metals are used for electrodes and the following results obtained: The negative glow is an extremely sensitive test for the weakest kinds of electric-light rays. Light of long wave-length behaves, so far as its influence upon the glow discharge is concerned, in a manner analogous to ultra-violet light and Röntgen rays; but while Röntgen rays, as Marx has shown, make it more difficult under certain conditions for the discharge to pass [see Abstract No. 515 (1909)], this is the case neither with ultra-violet light nor rays of long wave-length. Aluminium certainly, and in all probability a number of other metals also show the Hertz-Hallwachs effect with visible light; they contain such slow-moving electrons that these can be set free by light of long wave-length. When the experiments with quick oscillations are compared with those carried out with statical potential, it appears most likely that the quantity of electrons set free in the case of Au, Cu, Zn, Pt, and Ni, is so small that they can only in a slight degree diminish the lag, while with Al the action of visible light causes the lag to disappear. A. E. G.

1087. *Discontinuous Discharge in a Geissler Tube.* **H. A. Perkins.** (Comptes Rendus, 148. pp. 1170–1173, May 3, 1909.)—The discharge produced by an alternating current in a Geissler tube at a pressure of 0·1 mm. Hg is discontinuous. When the p.d. is raised to 600 volts, with Al electrodes 6 cm. apart, a feeble spark appears, and as the p.d. is increased, the spark and current become more intense, the dark space near the kathode in the discharge at this point being 1·5 cm. long. At a p.d. of over 800 volts the appearance of the discharge changes greatly, the positive column becoming weaker, and the kathode being surrounded with a halo of equal intensity both in front and behind, which is strongly deflected by a magnetic field, the direction of the deviation indicating the passage of electrons from behind the kathode towards the anode. In the feeble discharge, electrons are only produced on the front surface of the kathode, whereas in the stronger discharge electrons are also formed on its back surface. A noise is produced in a telephone receiver in series with the tube, at the moment when the discharge changes, and as the p.d. increases the sound becomes a clear note of increasing frequency, until at 2,000 volts its shrillness is painful. At still higher p.d.'s no sound is audible. Starting with a current of 6×10^{-6} amp. this gradually increases, till on reaching 6×10^{-5}, with p.d. 800 volts, there is a point of discontinuity in its curve corresponding with the change in the discharge. The p.d.'s necessary to start discharge and to produce discontinuous discharge vary with the distance between the electrodes, the former having a minimum value between 6 and 8 cm., and the latter at 4 cm. The discharge, when just becoming discontinuous, may be rendered continuous by means of a magnetic field, perpendicular to the axis of the tube, and near the kathode. W. H. Si.

1088. *Influence of High-potential Discharge on Amorphous Gold.* **B. G. Cobb.** (Chem. News, 99. pp. 209–210, April 30, 1909.)—A quantity of amorphous gold is precipitated from a solution of $AuCl_3$ by $FeSO_4$, washed thoroughly first with H_2O, then with HNO_3, and finally with distilled H_2O; every precaution being taken to obtain a pure product. 2 or 3 gm. of this is placed in a tube 6 in. long and 1 in. diam. furnished with rubber stoppers carrying Pt electrodes which terminate in circular discs. These electrodes are connected to the secondary terminals of a 10-in. coil and a spark discharge is passed for 30 min. The amorphous gold is then examined with the following results: (*a*) To all appearance it is unchanged; (*b*) some of it is placed, immediately after removal from the tube, in close proximity to a photographic plate contained in a holder, and so left for 20 min. When developed the plate is found to be fogged. The gold, however, soon loses this power, as on the next day it had little effect on the plate although the exposure lasted nearly twice as long. (*c*) When analysed the amorphous gold is found to contain distinct traces of copper. A. E. G.

1089. *Conduction of Electricity in Electro-negative Vapours.—The A_1 Rays.* **O. Reichenheim.** (Deutsch. Phys. Gesell., Verh. 11. 7. pp. 168–178, April 15, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—The conduction of electricity in electro-negative gases at low pressures has been investigated by Matthies and Bode [see Abstracts Nos. 150 (1906) and 2242 (1905)]. They found that the potential gradient in the case of the halogens and their compounds is abnormally high and increases from the kathode towards the anode. According to Matthies the anode-fall in these vapours may amount to several hundred volts. Gehrcke and Reichenheim [Abstract No. 845 (1908)] have, by using salt anodes, found that the anode-fall may amount to several thousand volts. At low pressures the potential gradient and the anode-fall in halogen vapours depend very largely upon the pressure and the current. As the pressure is decreased the anode-fall increases to a fixed limit; while for currents between 0·1 and 1 milliamp. it increases with an increase of current. At high pressures the reverse of this occurs. The simple explanation of this extraordinary behaviour of the halogen vapours may be that, in a higher degree than other vapours, they can absorb negative electrons. On this supposition other electro-negative vapours should behave in a similar manner. Such is proved to be the case for the vapour of phosphorus. A further consequence of this hypothesis is, that the anode-fall must decrease if an excess of negative electrons are admitted to the discharge tube, such as is the case when a Wehnelt kathode is used. This also is confirmed by experiment. It was further noted, as had been done many years since by Geissler and Hittorf, that when using phosphorus vapour the passage of the discharge causes it to change from the white to the red variety. At the same time it was found that this change brought about a marked decrease in pressure. Iodine vapour behaves similarly so far as the pressure is concerned. Further experiments are described to show that the red phosphorus deposit is for the most part negatively charged. A discharge tube having a perforated anode is used in order to ascertain whether any of the negative ions supposed to be formed will, in virtue of the high anode-fall, be carried behind the anode. This tube contained hydrogen and the vapour of iodine, and an anode-fall of 4,000 volts is obtained. It is then found that coming from the anode in the direction away from the kathode are rays which can be deflected by a weak magnet; but there are also other rays on which such a magnet has no apparent effect. Very strong magnetic fields, however, show that these latter rays consist of positively charged particles, and also probably of some which carry no charge. The new rays which proceed from the anode are in many respects analogous to the k_1 rays. These latter go in the same direction from the kathode as the kathode rays, but are positively, not negatively charged as one would expect, while the new rays, which it is proposed to call A_1 rays, proceed from the anode, and, contrary to expectation, are also positively charged. A tube is described by which these rays can be demonstrated.

A. E. G.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1090. *Theory of the Wehnelt Interrupter.* **P. Bary.** (Lumière Électr. 6. pp. 135–138, May 1, and pp. 172–175, May 8, 1909.)—The author first gives a historical *résumé* of the evolution of the interrupter. The phenomenon which it utilises was discovered by Fizeau and Foucault (Annal. Chim. Phys. 3. II., p. 383, 1844). It was subsequently studied by Koch and Wüllner (Wied. Ann. p. 478 and p. 759, 1892). The latest theory as to its action is that it is due to electromagnetic striction [see Abstract No. 1839 (1908)]. This theory, which is due to the author, has been subjected to an extensive series of experimental tests. Taken as a whole, the result of these tests confirm the theory but there are still one or two outlying difficulties. It is shown that the general equation of a variable current traversing a liquid must be of the form—

$$e = \mathrm{R}i + \frac{\mathrm{A}}{\eta}i^2 + \left(\mathrm{L} + \frac{\mathrm{B}d}{\eta^2}i^2\right)\frac{\partial i}{\partial t},$$

where d and η are the density and the coefficient of interior friction of the liquid, A and B two quantities which are very approximately constant, and the other symbols have their international meaning. The ordinary assumption that A and B are zero is unjustifiable.

A. R.

1091. *A Fallacy respecting the Law of Induction.* **H. Teege.** (Mitt. d. Mathemat. Gesell. in Hamburg, 4. 9. p. 445, 1909. Elektrotechnik u. Maschinenbau, 27. p. 396, April 25, 1909. Abstract.)—A magnetised iron ring is linked by a slip-ring to which a flexible wire is attached; the other end of the wire is connected to a galvanometer and thence to a brush in contact with the slip-ring which completes the circuit. When the slip-ring is rotated about its axis, wire is wound on or off the iron ring, and the number of magnetic linkages thereby increased or diminished, in spite of which the galvanometer remains undeflected.

J. D. C.

1092. *Effective Resistance and Inductance of Two Parallel Wires.* **J. W. Nicholson.** (Nature, 80. pp. 247–248, April 29, 1909.)—The author has extended and simplified the formula which he previously obtained [Abstract No. 531 (1909)]. Let us suppose that the alternating-current circuit consists of two cylindrical wires of the same dimensions, and let a, μ, and σ be the radius, permeability, and volume resistivity of a wire in c.g.s. units, f the frequency, and c the distance between the axes of the wires. Then for copper wires if $\lambda = 4\pi a(\mu f/\sigma)^{1/2}$, $\rho = \log_e [(2/8)\pi f/a \,.\, 10^{-10}]$ and λ is greater than 11 we have—

$$L = 4\left(1 - \frac{a^2}{\rho c^2}\right)\log_e\frac{c}{a} + \frac{4}{\lambda}\left(1 - \frac{2}{\lambda}\right) - \frac{4a^2}{\lambda c^2\rho^2}\left\{\rho - (4\rho + 8)\log_e\frac{c}{a}\right\}$$

and—

$$\frac{R}{8\pi f} = \frac{1}{\lambda}\left(1 + \frac{1}{\lambda}\right) - \frac{a^2}{\lambda c^2\rho^2}\left\{\rho - (2\rho - 1)\log_e\frac{c}{a}\right\} + \frac{a^2}{\lambda^2 c^2\rho^3}\left\{\rho^2 - (2 - 8\rho + 2\rho^2)\log_e\frac{c}{a}\right\},$$

where $1/\lambda^3$, a^4/c^4, and $a^2/\lambda^2c^2\rho$ have been neglected. These formulæ are applicable when the frequency is high. Similar formulæ are given which are suitable when the frequency is low. Formulæ suitable for iron wires with high- and low-frequency currents are also given. A. R.

1093. *Method for Simultaneous Measurement of E.M.F.'s and Internal Resistances which are subject to Continuous Variation.* **J. Rožič.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 1227–1230, Oct. and Nov., 1908.)—In connection with electrical experiments on the human body it has been necessary for the author to design an apparatus by means of which the e.m.f. and the resistance of the body, both being subject to continual variation, can be simultaneously measured. By means of a specially designed commutator (about 100 commutations per sec.) the current from the human body could be passed through two different circuits of known resistances and measured by means of two delicate d'Arsonval galvanometers. Two equations are thus obtained, viz., $C = E/(R + R_1)$ and $C' = E/(R + R_2)$, where R, the resistance of the body, and E, the e.m.f., are the two unknowns, C and C′ being the currents measured by the galvanometers, and R_1 and R_2 the resistances of the external circuits. E and R can thus be calculated.

T. S. P.

1094. *Temperature-coefficients of the Moving-coil Galvanometer.* **A. Zeleny** and **O. Hooda.** (Phys. Rev. 28. pp. 277–290, April, 1909.)—The authors have made determinations of the temperature-coefficients for current measurements, potential measurements, and ballistic measurements on two galvanometers having chilled cast-iron magnets. The galvanometer was enclosed in a double-walled jacket maintained at a definite temperature by means of water which circulated between the walls of the jacket. A constant current was put through the moving coil at various temperatures, when it was found that the mean value of the temperature-coefficient for the deflections thereby produced is approximately + 0·00018 using a phosphor bronze (8-mil) suspension, and + 0·00005 with a steel suspension. The corresponding coefficients for potential measurements are respectively + 0·00018 — B, and + 0·00005 — B, where B is the resistance-coefficient of the galvanometer circuit. The coefficient for ballistic throws works out in both cases to — 0·00017. These results when compared with those obtained by calculation of the temperature-coefficients of various parts of the galvanometer agree as closely as can be expected, considering the sources of error. In discussing the results the authors show how large a part the magnetic impurities play in the directive action upon the coil. The magnets of the galvanometers they used had a field intensity of 425 units and a temperature-coefficient of — 0·00040. The ratio of the restoring moment due to the magnetic impurities in the coil to that due to torsion of the suspension was determined from the periods of vibration of the system when in the magnetic field and when outside it. It was found equal to about 0·07. On putting the coil between the poles of a strong electromagnet this ratio became equal to unity. W. C. S. P.

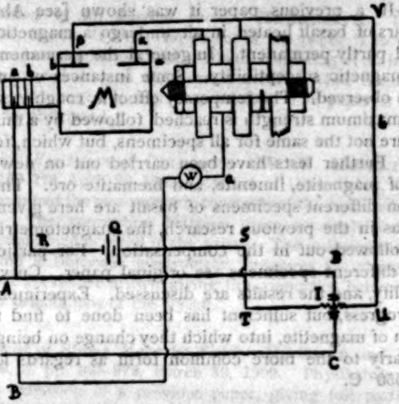
1095. *Theory of Ballistic Galvanometers of Long Period.* **B. O. Peirce**. (Amer. Acad., Proc. 44. No. 11. pp. 283–314, March, 1909. Contribution from the Jefferson Phys. Lab., Harvard Univ.)—Making the assumption that the damping couple is exactly proportional to the angular velocity, the author obtains the solution of the Gaussian equation of a ballistic galvanometer in a very convenient form for practical purposes, and discusses the various cases. He points out the curious one-sided effect which is noticed with most d'Arsonval galvanometers. In some cases the throws on one side were 2 per cent. greater than on the other. If the mean of the throws on the two sides be taken, however, it is found that accurate results can be obtained. The author gives the results of experiments which show how wonderfully close the actual observed values are to the theoretical values deduced from Gauss's equation. A very careful study is made of the conditions that a galvanometer must satisfy in order that it may measure accurately a slow rush of electricity through it. A. R.

1096. *Double Oscillograph for Lecture Demonstration.* **F. Piola.** (N. Cimento, 17. pp. 27–47, Jan.–Feb., 1909. Elettricista, Rome, 8. pp. 81–86, March 15, 1909.)—The apparatus is intended to demonstrate the influence on the amplitude and phase of an alternating current, exerted by the resistance, self-inductance, and capacity of the conductor carrying the current itself, and consists of two rectangular copper-wire frames, placed at right angles, and one inside the other, and oscillating on vertical and horizontal wires. A small mirror is affixed to the horizontal frame in a plane parallel to that of the two axes of oscillation, and the apparatus is placed directly normal to the axis, in a constant magnetic field produced by a Faraday electromagnet or by a permanent magnet. W. H. Si.

1097. *Double Rheograph.* **H. Abraham.** (Journ. de Physique, 8. pp. 265–274, April, 1909.)—The author gives an elementary theory of his rheograph, and indicates some of the modifications which have recently been made in the instrument. It is stated that it is practically accurate up to frequencies of some thousands. It is peculiarly suited for projecting an image on a screen, as a very light movable coil is not essential, and the surface of the mirror may be as large as half a square centimetre. In the new apparatus the first term of the Gaussian equation $Mk^2\ddot{q} + B\dot{q} + Cq = Pi$, where q denotes a certain quantity of electricity, has a preponderating value, the damping and restoring couples being negligibly small in proportion. This has been effected by suspending the coil by a wire having a very feeble couple of restitution, and using a permanent magnet so as to diminish the damping. The mechanical and electrical parts of the problem, therefore, have been greatly simplified, all that has to be done is to obtain a current in the moving coil proportional to $\ddot{q}$. This current is obtained by acting on the moving coil by induction exclusively. When the circuit connected with the rheograph transmits suddenly a finite quantity of electricity, the moving coil turns practically instantaneously through an angle proportional to this quantity. Thus the rheograph is a ballistic galvanometer which gives instantaneous indications. The sensibility as a ballistic galvanometer is not great. With a coil having a resistance of 15 ohms, the deflection on the scale one metre away is about 1 mm. per coulomb. Its value mainly consists in measuring a series of discharges taking place very rapidly. The accuracy of the instruments is very satisfactory, the curves being practically identical with those given by the Blondel oscillograph. The author points out that his instrument gives a striking illustration of the accuracy of the fundamental laws of dynamics and electrodynamics. The action of the instrument depends on two differentiations by electric actions, and an integration by a dynamic action. The trace produced by the instrument is in practically exact agreement with what it should be theoretically. A. R.

ALTERNATING CURRENTS AND MAGNETISM.

1098. *Method to establish some Relations in Alternating Currents.* **G. C. Trabacchi.** (Elettricista, Rome, 8. pp. 83–84, Feb. 1, 1909.)—The alternating p.d. between A and B is included in the circuit ABCD, in which are also two fixed coils of an electrodynamometer I. M is a wooden drum, rotated by a motor, making one revolution for each period of the current AB, and closing the circuit RSTUV at regular intervals, which are equal and whole multiples of the period, permitting the passage of the current from the battery Q through the free coil of I at the exact moment when the alternating current, passing in the fixed coils, has a given value. By means of a brush β which rotates on an axis P, contact may be made at any point of the period, enabling the form of the current to be traced in common with the ordinary oscillograph, operating all the time in a closed circuit. A second contact on M through the brush α inserts a quadrant electrometer or galvanometer of high resistance directly between A and B, which takes a definite position for each angular value of the position of the brush, and the angle between α and β represents the difference of phase between the e.m.f. and the current in the circuit ABCD. Such an apparatus is suitable for lecture demonstration, showing clearly the effects of capacity and self-inductance in the circuit ABCD, as well as the difference in phase between two sinusoidal currents.



W. H. St.

1099. *Propagation of Waves of Magnetic Flux along Iron Rods.* **L. Lombardi.** (N. Cimento, 17. pp. 12–26, Jan.–Feb., 1909.)—The conflicting results of previous workers on the subject are attributed to their neglect of the permeability and of the coefficient of dispersion, Lyle and Baldwin [Abstract No. 2091 (1906)] alone including the permeability among the factors. The value of the coefficient of dispersion can only be determined when the form of the tubes of flux dispersed from the surface of the rod is exactly known, but the difficulty may be overcome by arranging the magnetised rod in two parallel lines separated by a short distance. Then if ϵ is the coefficient of dispersion, D the distance between the axes of the rods, and d their diam., in a medium of μ_0 permeability, $\epsilon = 2\pi\mu_0/\log(2D/d)$, or if in the air, $\mu_0 = 1$, and the value becomes $2\pi/\log(2D/d)$. For both continuous and alternating currents, V, the magnetic potential $= Ae^{+\beta x} + Be^{-\beta x}$, where $\beta = \sqrt{(\epsilon/\mu s)}$, μ and s being respectively the permeability and section of the rod; and direct measurements of the induction agree well with those calculated in this way, the mean error being less than 1 per cent. The hysteresis of the iron, though neglected alike by the present and previous workers, probably plays an important part in magnetic propagation, and it is concluded that the velocity of propagation is controlled by the secondary current developed in the rod, and when this ceases tends to become indefinitely increased. W. H. St.

1100. *Magnetism of Basalt.* **G. E. Allan.** (Phil. Mag. 17. pp. 572–581, April, 1909.)—In a previous paper it was shown [see Abstract No. 1157 (1904)] that bars of basalt heated in air undergo a magnetic change, partly temporary and partly permanent. In general the permanent effect consists in a loss of magnetic susceptibility. Some instances of an increase have, however, been observed. The temporary effect is, roughly, similar to that in magnetite; a maximum strength is reached, followed by a minimum strength at a temperature not the same for all specimens, but which, for most cases, is about 600° C. Further tests have been carried out on new bars of basalt, and on bars of magnetite, ilmenite, and hæmatite ore. The results of the experiments on different specimens of basalt are here given. The method adopted was, as in the previous research, the magnetometric, and Erhard's method was followed out in the compensation. For particulars of results obtained with different specimens see original paper. Curves are given for the susceptibility, and the results are discussed. Experiments on hæmatite ores are in progress, but sufficient has been done to find that the second allotropic form of magnetite, into which they change on being heated to 400°, behaves similarly to the more common form as regards loss of magnetic power about 550° C. A. W.

ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

1101. *The Grisson Electrolytic Interrupter.* **T. Nogier.** (Archives d' Él. Médicale, 17. pp. 837–848, May 10, 1909.)—The rotating commutator used in connection with an electrolytic condenser for operating induction coils is well known. In the present article the author gives a useful table of the times of exposure necessary for obtaining radiograms of different parts of the human body, according as 2, 4, 6, 8, or 12 such condensers (each of 500 mfd. capacity) are employed. For the highest speed of the commutator and 12 condensers, the exposure required at 45 cm. distance is only 0·6 sec. for the thorax and 2 sec. (at 50 cm.) for the pelvis, the rays being of radiochromometric intensity 7·5–8 (Wehnelt). L. H. W.

REFERENCES.

1102. *Electromagnetic Theory.* **G. Fubini.** (Accad. Lincei, Atti, 18. pp. 885–890, April 18, 1909.)—The paper is complementary to two previous ones [see Abstracts Nos. 858 and 2030 (1908)] and completes the discussion begun in those papers. S. G. S.

1103. *Dispersion in the Electric Spectrum of Water.* **A. R. Colley [Kolli].** (Phys. Zeitschr. 10. pp. 329–340, May 15, 1909.)—A translation of the paper dealt with in Abstract No. 2096 (1907).

1104. *Electrometer.* **T. Wulf.** (Phys. Zeitschr. 10. pp. 251–258, April 15, 1909.)—A further description of the author's electrometer for static charges. Modifications are described which render the instrument suitable for use in ships or balloons and enable it to be transported fully charged. [See also Abstracts No. 1087, 1910 (1907).] A. W.

1105. *Estimation of Small Capacities.* **T. Wulf.** (Phys. Zeitschr. 10. pp. 258–264, April 15, 1909.)—Describes a method of determining small capacities, such as those of Ebert's and Elster and Geitel's apparatus, by means of the author's electrometer. The method is a modification of that given by Harms [Ibid. 5. p. 47, 1904; also Abstract No. 156 (1904).] A. W.

1106. *Determination of an Electric Field.* **Hadamard.** (Annal. Chim. Phys. 8. pp. 403–432, March, 1909.)—The object of the paper is to determine the electric field between two conductors, one of which, consisting of an infinite number of rectangular teeth spaced at equal distances, is earthed, while the other—a plane parallel to the teeth—is charged to a given potential. The paper is purely mathematical and cannot be abstracted. T. P. B.

1107. *Piezo-electric Excitation of Cane-sugar.* **W. F. Holman.** (Ann. d. Physik, 29. 1. pp. 160–178, April 22, 1909. Extract of Dissertation, Greifswald.)—The author has determined the piezo-electric constants of the hemihedral monoclinic crystal cane-sugar. The connection between these constants and the electric moment due to a certain load is given in the paper. The ordinary method of loading is employed, and a Dolezalek electrometer measures the charge. Tables of results are given, and curves are drawn giving the connection between the electric moment and various orientations of the crystal. T. P. B.

1108. *Measurement of Strong Magnetic Fields.* **R. Gans and P. Gmelin.** (Ann. d. Physik, 28. 5. pp. 925–978, March 30, 1909. Physikal. Inst., Tübingen, Jan. 18, 1909.)—An extension of a previous paper, giving full particulars of the methods employed to determine the constants of the split-ring electromagnets used as standards, in the use of which an accuracy of 0·2 per cent. is assured. [See Abstract No. 1915 (1907).] G. E. A.

1109. *Polar Magnetic Storms in 1882–1883.* **Birkeland.** (Comptes Rendus, 148. pp. 1006–1009, April 13, 1909.)—In previous papers a theory has been outlined for explaining the origin of magnetic perturbations [Abstracts Nos. 2027 (1908), 550 (1909)]. More recently eight magnetic storms have been studied in detail, and one of these is discussed in the present paper. C. P. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1110. *Electric Transformer Melting Furnace.* **H. Helberger.** (Elektrochem. Zeitschr. 16. pp. 5–8, April, 1909.)—The author inserts his crucible directly into the secondary circuit of a transformer, and wishes to heat the graphite crucible, not its metallic contents as in the case of induction furnaces. Metals must therefore be insulated from the walls of the crucible. The crucible stands in a cylindrical case on a water-cooled electrode and is surrounded by jackets of fire-clay. The other electrode is a ring which is screwed down upon the crucible. The crucible is made of a mixture of fire-clay and graphite, whose proportions are varied in different parts of the crucible, so as to produce high temperatures in certain parts of the latter. This arrangement is used for melting glass, enamel, &c. When metals are to be melted the crucible is either provided with an insulating lining, or the graphite is burned out of the surface; the latter process is preferable, and is carried out with the blowpipe, or by passing air through the hot crucible, or with the aid of nitric acid or of fused silicates. The furnaces are built for charges of 10 kg. H. B.

1111. *Apparatus for demonstrating the different Velocities of Electrolytic Ions.* **U. Cialdea.** (N. Cimento, 17. pp. 69–70, Jan.–Feb., 1909.)—This apparatus resembles that devised by Loeb and Nernst for the determination of Hittorf's transport numbers, but has no tap in either of the side-tubes. A solution of zinc chloride, for example, is electrolysed so that the zinc ions arriving at the kathode find there chlorine with which to re-form zinc chloride, whilst the chlorine ions similarly find zinc at the anode. This is effected by using a spiral of zinc wire as anode, and a spiral of silver wire coated with silver chloride as kathode. As the velocities of the zinc and chlorine ions differ considerably, about 10–20 min. after closing the circuit a concentration cell is formed, as may be seen by connecting two auxiliary electrodes, one in each limb, through a galvanometer or electrometer sensitive to 0·001 volt; these auxiliary electrodes are of Pt wire, the ends being covered with a thin layer of granulated zinc or zinc amalgam. The sense of the e.m.f. shows that the greater concentration of zinc chloride is at the anode. Diffusion in the electrolyte may be avoided by suspending the apparatus in a thermostat, and by using currents of 10–50 milliamps. T. H. P.

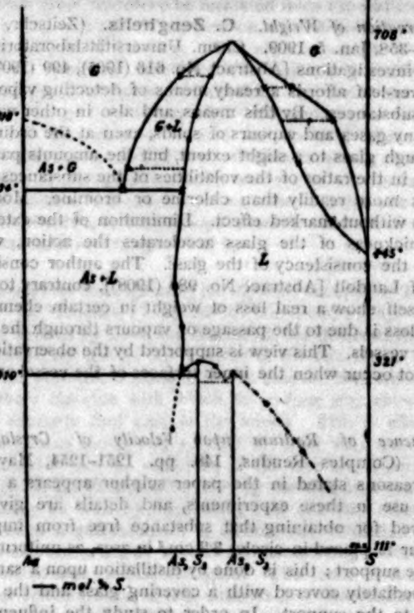
1112. *Atomic Weights as Mathematical Functions.* **F. H. Loring.** (Chem. News, 99. pp. 148–151, March 26, 1909.)—The author plots out (against the atomic weights) the differences between the observed atomic weights and the equally-spaced values derived from the formula $W = 8 \cdot 1 \pm 4n$, and shows that these fall on a series of elliptical curves having a common focus and a major axis which is fixed in position but variable in length. T. M. L.

1113. *Rapid Demonstration of the Phenomenon of Dialysis.* **U. Cialdea.** (N. Cimento, 17. pp. 71–72, Jan.–Feb., 1909.)—This method makes use of a dialyser containing distilled water in both inner and outer vessels, into each of which dip two electrodes consisting of glass tubes with pieces of Pt sealed into the ends and containing a little mercury. The inner and outer liquids are arranged in two different circuits, each of which contains a telephone and both of which are served by the same induction coil or town mains. When the dialyser contains only water the telephones show no current, and the same is the case when a colloid such as ferric hydroxide is introduced into the inner vessel. When, however, a few drops of saturated sodium or lithium chloride solution are added the telephone of the inner vessel circuit sounds immediately and the other after a few minutes. It can be shown spectroscopically that the sodium or lithium chloride has diffused into the outer vessel, but that the colloid remains in the inner one. T. H. P.

1114. *Conservation of Weight.* **C. Zenghelis.** (Zeitschr. Phys. Chem. 65. 3. pp. 341–358, Jan. 5, 1909. Chem. Universitätslaboratorium, Athen.)—In his former investigations [Abstract No. 616 (1905), 499 (1907)] the author found that silver-leaf affords a ready means of detecting vapours of metals and of other substances. By this means, and also in other ways, it is now found that many gases and vapours of solids, even at the ordinary temperature, pass through glass to a slight extent, but the amounts passing through are not always in the ratios of the volatilities of the substances; thus, iodine traverses glass more readily than chlorine or bromine. Moderate rise of temperature is without marked effect. Diminution of the external pressure and of the thickness of the glass accelerates the action, which is also dependent on the consistency of the glass. The author considers that the experiments of Landolt [Abstract No. 986 (1908)], contrary to the views of the latter himself, show a real loss of weight in certain chemical reactions and that such loss is due to the passage of vapours through the glass walls of the containing vessels. This view is supported by the observation that loss in weight does not occur when the inner surfaces of the vessel are coated with paraffin wax. T. H. P.

1115. *Influence of Radium upon Velocity of Crystallisation.* **L. Frischauer.** (Comptes Rendus, 148. pp. 1251–1254, May 10, 1909.)—For various reasons stated in the paper sulphur appears a most suitable substance for use in these experiments, and details are given as to the means employed for obtaining that substance free from impurities. The purified sulphur is placed in circles 3·2 cm.^{2} in area, as uniformly as possible upon a suitable support; this is done by distillation upon a sand bath. The deposit is immediately covered with a covering glass and the edges of this are cemented to the support. In order to study the influence of the Ra radiations, each of the preparations is partly covered with a layer of Pb 5 mm. in thickness. 25 mgm. of pure $RaBr_2$ contained in a thin glass bulb is placed 6 mm. above the centre of the sulphur deposit. In the part A exposed to the rays there is seen in all cases after 3 hours' exposure an increase in the number of centres of crystallisation in the neighbourhood of the bulb. In a day or two this number attains a value double that in the part B protected by the Pb screen. Beside this increase in the number of centres in A, after the second day there is seen to be a propagation of crystallisation from drop to drop, so that at the end of the fourth day the total number of crystallised drops in A is 3 to 5 times greater than in B. Even after 28 days' exposure a certain number of drops in A still retain their transparency, but when heated for six hours at 70° C. they all crystallise in A but not so in B. The action of Ra emanation is next examined with like result, and from the arrangement of the experiment it is concluded that the results obtained are due less to the α-rays of the emanation than to the induced activity. Röntgen rays produce no such effects, and it is therefore suggested that the increase in velocity of crystallisation is due to β-rays, since the α-rays are cut out by the glass of the tube containing the radium preparation. **A. E. G.**

1116. *Sulphur and Arsenic.* **W. P. A. Jonker.** (Zeitschr. Anorg. Chem. 62. 2. pp. 89–107, April 17, 1909. Communication from the Chem. Laborat. d. Univ., Amsterdam.)—The equilibrium of sulphur and arsenic is heterogeneous. The Fig. embodies the author's results, G indicating gas phase, and L liquid phase. As_2S_2 is dissociated not only in the gas phase (as is already known), but also in the liquid state. As_2S_3 can be distilled without dissociation. As to the existence of As_2S_5 no information was obtained. **F. R.**



1117. *Molten Sulphur.* I. *Equilibrium Isomerism of Liquid Sulphur.* **A. Wigand.** (Ann. d. Physik, 29. 1. pp. 1–31, April 22, 1909. Physikal. Inst. d. techn. Hochschule, Dresden, Feb., 1909.)—The molecular weight of sulphur is now found to be the same in both the soluble and insoluble forms, corresponding with the formula S_8; so that, in the change from the one to the other form, neither association nor dissociation occurs, but an intramolecular change without alteration of the molecular weight. The equilibrium constants between 117·1° and 119·6° have been redetermined by the freezing-point method and the melting-point of pure monoclinic sulphur found to be 118·95°. The heat of transition $S_{\text{liquid sol.}} \longrightarrow S_{\text{liquid insol.}}$, calculated from the new values of the equilibrium constants, is —28·0 gm.-cals. per gm. of sulphur [see also Abstract No. 156 (1909).] T. H. P.

1118. *Molten Sulphur.* II. *Action of Light on the Equilibrium in Molten Sulphur.* **A. Wigand.** (Ann. d. Physik, 29. 1. pp. 82–88, April 22, 1909. Physikal. Inst. d. techn. Hochschule, Dresden, Feb., 1909.)—By the action of light, the equilibruim $S_{\text{sol.}} \rightleftarrows S_{\text{insol.}}$ is displaced from left to right. Under the conditions of the author's experiments the equilibrium constant in the light amounts to 10 per cent. more than the value in the dark at 18°. [See also Abstract No. 126 (1909).] T. H. P.

1119. *Fusibility of Mixtures of Gold and Tellurium.* **H. Pélabon.** (Comptes Rendus, 148. pp. 1176–1177, May 3, 1909.)—Gold readily dissolves in molten Te, the solidifying-point curve for such mixtures showing a eutectic at 415° C., corresponding to 16·5 per cent. Au, and reaching a maximum at 472° for mixtures containing 41–45 per cent. Au, which represent approximately Au_3Te_4. W. H. Si.

1120. *Silicon-Calcium Alloys.* **S. Tamaru.** (Zeitschr. Anorg. Chem. 62. 2. pp. 81–88, April 17, 1909. Metallographic Communication from the Inst. f. physikal. Chemie d. Univ., Göttingen.)—These alloys, prepared from calcium containing 99·17 per cent. Ca, and silicon containing 92·48 per cent. Si, have been investigated by the method of thermal analysis, the results being controlled by alloys made from 99·2 per cent. Si. Alloys prepared in a nitrogen atmosphere always contained some of the red calcium nitride Ca_3N_2, while those made in a hydrogen atmosphere contained calcium hydride though in lesser quantities. In the liquid state, Ca and Si are miscible in all proportions, and the melting-point of Si is rapidly lowered by the addition of Ca. Investigation of the Ca-rich alloys (above 29 per cent. Ca) is very difficult on account of their very low heats of solidification; it being impossible to observe any breaks, corresponding to the commencement of freezing, in the cooling curves of the alloys. At 990° C. the alloys containing 88 to 82 per cent. Si undergo thermal transformations corresponding to the formation of the compound $CaSi_2$. F. C. A. H. L.

1121. *Acid-resisting Alloys.* **A. Jouve.** (Faraday Soc., Trans. 4. pp. 155–158, April, 1909. Engineering, 86. p. 25, July 3, 1908.)—Further particulars are given of the uses for ferro-silicons referred to in Abstract No. 496 (1908). The difficulties in the way of obtaining castings from these alloys strong enough to withstand cooling stresses have been overcome by small additions of other metals (not specified), and Al is usually added. The alloys are unaffected by nitric acid (even vapour), sulphuric, hydrochloric, and acetic acids; and figures relating to tests of the effect of 20 per cent. nitric acid and 18 per cent. sulphocyanide of aniline show that the alloys are much more resistant to these liquids than other metals that are in use for vessels to contain them.
F. R.

1122. *Polishing Metals for Microscopic Examination.* **A. Kingsbury.** (Amer. Soc. Mech. Engin., Journ. 31. pp. 615–618, May, 1909. Mech. Eng. 23. pp. 676–677, May 28, 1909.)—The author finds that instead of methods hitherto proposed, it is preferable to melt a bed of paraffin wax about ¼ in. deep upon the metal disc, true this when cold, and use as the polishing surface. Wet pastes of the following four commercial powders, used in the order given, are found suitable: Commercial flour emery; washed Naxos emery, 3/0 grade; washed Naxos emery, 7/0 grade; soft optical rouge, light grade. At the first few touches, unless very light, paraffin will adhere to the sample, particularly in the case of the rouge disc. F. R.

1123. *Graphitic Oxide, and Definition of Graphite.* **G. Charpy.** (Comptes Rendus, 148. pp. 920–923, April 5, 1909.)—When samples of carbon and of graphite from various sources are submitted to the action of oxidising mixtures at suitable temperatures and for suitable periods graphitic oxide is in some instances obtained from types which have hitherto been classed as amorphous carbon. Hence it does not appear sound to base the definition of graphite upon the behaviour with Brodie's reagent (mixture of fuming nitric acid and potassium chlorate) without additional restrictions as to the conditions of carrying out the test. In view of the work of le Chatelier and Wologdine on graphite [see Abstract No. 382 (1908)], the density of the repeatedly compressed sample would be a more reliable criterion. Thus it is found that so-called "pyrographitic oxide," the production of combustion of graphitic oxide, is graphite. So also is the carbon residue obtained by dissolving steel in copper chloride. F. R.

1124. *Nature of the Cast Irons.* **G. B. Upton.** (Journ. Phys. Chem. 13. pp. 388–416, May 1909.)—The iron-carbon equilibrium is again taken up [see Abstract No. 2042 (1908)] with special reference to the higher carbon portion of the series, *i.e.*, the range of the commercial cast irons. Regarding the author's explanation of the 800° inversion, Osmond has suggested that Carpenter and Keeling's specimens had become decarburised superficially, and so gave the β to α inversion of low-carbon steels. The author's view is that the characteristic (highest) temperature of the 800° inversion is 800°; that of the β to α is 785°, so that Osmond's explanation does not hold. Similarly Rosenhain's suggestion that the 600° point is due to an evolution of heat from the quartz of the furnace is dismissed on the ground that the characteristic temperature of the quartz inversion is 585°, whilst that of the 600° inversion is 615°. The "displacing power" of nitrogen is given as about 0·2, in the same direction as that of phosphorus. Sometimes a "suspended equilibrium" may be obtained approximately along CLN [see Abstract referred to above] in high-carbon steels annealed for a long time at very high temperatures and slowly cooled. Cementite disappears from a 1·8 per cent. carbon steel heated to 900° and the structure becomes $\gamma + Fe_4C$, but Fe_4C does not occur in any appreciable amount in commercial products, as its heat of formation is low, and it is produced only very slowly. γ here is solid solution of carbon in γ-iron, and the author states that he does not insist that Fe_4C is an actual compound, as the case would be equally well met by a narrow field of a solid solution with a limiting concentration of about 8·5 per cent. carbon. F. R.

1125. *Corrosion of Iron.* (Amer. Electrochem Soc., Trans. 14. pp. 151–178, 1908. Discussion.)—**A. F. Ganz** opened the discussion with a number of important general considerations. He had failed to differentiate between the corrosion of underground pipes which was attributable to electrolytic action due to positive potential of the pipe system with respect to the ground, and that in which such a p.d. did not exist, *i.e.*, ordinary rusting. Coating with bituminous compounds had failed, in his experience, and serious local corrosion had resulted. Coating with concrete had in one case, where the pipe had an appreciable positive potential, actually hastened corrosion. A limiting safe current-density is tentatively set at from 1 to 10 milliamps per sq. ft. of pipe surface. 1 milliamp. would corrode 0·0005 in. of iron per sq. ft. per year, and if assumed localised on 10 per cent. of the surface it would take 20 years to produce pittings 0·1 in. deep. **A. S. Cushman** emphasised the point that all corrosion was electrolytic in nature—at least locally. **M. Toch** referred to a paper on the corrosion of steel embedded in cement, in which he correlated rate of corrosion with acidity and alkalinity of aqueous solutions. **C. Hering** considered the expense of attaching zinc to valves and important fittings on underground plant was warranted by its protective value. **C. H. Sharp** referred to the method of determining fall of potential in a length of pipe by leads from selected points, connected to voltmeter or millivolt-meter, and states that he has in some cases, when the resistance of the pipe was high, had better results by using heavy leads and an ammeter and voltmeter. Harber's earth ammeter, which is an ammeter connected to two plates buried in the ground, each in contact with a salt of the same material so as to avoid polarisation, is open to the objection that disturbance of the normal condition of the ground is necessary. F. R.

1126. *New Form of Pearlite.* **C. A. F. Benedicks.** (Iron and Steel Times, 1. pp. 185–188, May 6, 1909.)—On heating a cast iron (carbon 8·9, Si 0·75 per cent.) for some time at 670° C. high magnification showed besides laminated and granular pearlite an intermediate form, in which, instead of lamellæ of cementite, strings of cementite beads were found. The probable mode of formation of this structure is discussed, and photomicrographs are given. With a further 2 hours' annealing above 600°, all the pearlite was transformed into the granular form. F. R.

1127. *Function of Oxygen in Corrosion.* **W. H. Walker.** (Amer. Electrochem. Soc., Trans. 14. pp. 175–187, 1908.)—Friend's view that the electrolytic theory of corrosion of iron is untenable [see Abstract No. 1869 (1908)] is founded upon results obtained with iron washed in caustic soda, which the author points out has a protective influence, and which he has shown by conductivity tests to be held by the iron in spite of washing. In other respects it is shown that Friend's results may be equally well explained by the electrolytic theory. Probably the accelerative effect of oxygen lies in its power of destroying the continuity of the hydrogen film already separated upon the surface of the iron. A piece of steel bar, partially cleaned and in part still coated with rolling-mill scale, corroded in water at the rate of 0·86 gm. per week, whilst a completely cleaned piece of the same bar only corroded 0·56 gm. per week. The barbs of barbed-wire fencing which are cut after galvanising and making up soon corrode at the tips where iron is exposed. It is proposed to plate the tips electrolytically. The rate of solution of zinc-iron alloys in 2 per cent. sulphuric acid increased rapidly with increase of iron content up to 7 per cent. Fe. The rate of corrosion of iron in salt solutions decreases with increasing concentration, and is much diminished with zinc in contact with the iron, whilst the zinc dissolves. In protecting boilers with Zn, there must be good contact between Zn and steel, and the water must contain sufficient electrolyte of some sort to ensure a low enough resistance so that a current may pass from Zn to Fe. An alkaline solution of tannin or an ordinary tannin extract is an efficient anti-corrosive in boilers. F. R.

1128. *Rusting of Iron and Steel.* **A. Schleicher.** (Metallurgie, 6. pp. 182–190, March 22, and pp. 201–218, April 8, 1909.)—Numerous experimental results are given showing the p.d. between cast and wrought iron, and mild steel, bright or rusty, and nickel, chromium, and tungsten steels, chiefly in Munich water as electrolyte. Generally the corrodibility of any of these metals in a given water will depend upon whether it is in contact with another metal or not, upon the amount of water surface exposed to the atmosphere, and will be different according as the electrolyte is moving or at rest. After a few hours the potentials of mild, tungsten, and chromium steels, initially much different, became practically alike; that of 25 per cent. nickel steel, however, became distinctly higher (positive). The presence of rust, which has formed on all except the high nickel steel in this time, probably explains their similar behaviour. In the two following lists the most highly positive samples are at the top, and negative at the bottom:—

By Terminal Voltage.	By Single Potential, Hours from Commencement of Test.		
	0	8	50
Wrought iron I.	Wrought iron I.	Wrought iron I.	Wrought iron I.
Hard steel	Hard steel	Hard steel	—
Wrought iron II.	Soft steel	Soft steel	—
Mild steel I.	Mild steel I.	Wrought iron II.	—
Mild steel II.	Charcoal iron	Charcoal iron	Mild steel II.
Soft steel	Wrought iron II.	Cast iron II.	—
Charcoal iron	Mild steel II.	Mild steel I.	—
Cast iron I.	Cast iron II.	Mild steel II.	—
Cast iron II.	Cast iron I.	Cast iron I.	Cast iron I.
Nickel steel (25 per cent.)	Nickel steel (25 per cent.)	Nickel steel (25 per cent.)	—
Nickel steel (5 per cent.)	Nickel steel (5 per cent.)	Nickel steel (5 per cent.)	—
Chromium steel	Chromium steel	Chromium steel	—
Tungsten steel	Mild steel I.	Tungsten steel	—
Mild steel I.	Tungsten steel	Mild steel I.	—

The transient positive potential of certain samples is attributable in part to the potential of oxygen present. This is increased by preliminary treatment of the metal with dichromate, hence the now well-known passivity of iron so treated. The author considers the tendency of a metal to form oxygen electrodes to be the principal factor deciding the difference in its behaviour as compared with other samples. This tendency depends upon the condition of the surface, and upon structure. F. R.

1129. *Heat of Formation of Titanic Oxide, and Heat of Combination of Acidic Oxides with Sodium Oxide.* **W. G. Mixter.** (Amer. Journ. Sci. 27. pp. 393–397, May, 1909. Contribution from the Sheffield Chem. Lab., Yale Univ.)—The method used in these determinations consisted in burning a coarse powder of pure Ti in sodium peroxide—

$3Na_2O_2 + Ti = Na_2O \,.\, TiO_2 + 2Na_2O +$ .... 227,100 Cals.

$3Na_2O + 3O = 3Na_2O_2 +$ .... 58,200 „

285,300

$Na_2O + TiO_2 + O = Na_2O \,.\, TiO_2$ .... 69,700 „

$Ti + 2O = TiO_2$ (amorphous) + ... 215,600 „

$Na_2O_2 + TiO_2 = Na_2O \,.\, TiO_2 +$ .... 50,300 „

$Na_2O + O = Na_2O_2 +$ .... 19,400 „

$Na_2O + TiO_2 + O = Na_2OTiO_2 +$ .... 69,700 „

The following results and calculations are given for the heat of combination of lead and lead oxide with sodium oxide :—

$2Na_2O_2 + Pb = Na_2PbO_3 + Na_2O +$	68,500	Cals.
$2Na_2O + 2O = 2Na_2O_2 +$	88,800	"
$2Na_2O + 2O + Pb = Na_4PbO_4 +$	102,800	"
$Pb + 2O = PbO_2 +$	62,400	"
$2Na_2O + PbO = Na_4PbO_4 +$	39,900	"

With zirconium dioxide no good fusions were obtained, and the only interpretation to be given to the results is that the heat of ZrO_2 or $ZrO_2 + Na_2O$ is small. With ceric oxide only one experiment was made, and the thermal result does not indicate combination of sodium oxide with an oxide of cerium.
C. O. B.

1130. *Action of Magnesium with Carbonates.* **H. R. Ellis.** (Faraday Soc., Trans. 4. pp. 172–174, April, 1909.)—Mixtures of magnesium powder with carbonates react throughout the mass if ignited in one portion. The results show that probably amorphous carbon is first produced, and more or less of this is converted into graphite at the high temperature of the reaction. With ammonium, magnesium, and cadmium carbonates no nitride, cyanide, or carbide was formed. Heated magnesium was burned in a stream of CO_2. Carbon, of which 12 per cent. was graphite, was formed, and also a trace of magnesium carbide.
F. R.

1131. *Heat of Solution of Ammonia in Water.* **H. Mollier.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 422–424, March 13, 1909. Communication from the Laborat. f. techn. Physik d. Kgl. techn. Hochschule, München.)—The author's previous results [Abstract No. 2059 (1908)] show that the heat of absorption of ammonia diminishes rapidly with rise of concentration of the solution. In the present paper are given a number of results of measurements of the heat of solution of liquid ammonia in water and in ammonia solutions of various concentrations. A table is given showing the heat evolved on mixing 1 gm. of liquid ammonia with an x_1 per cent. ammonia solution, the final concentration being x_2 per cent. ; the numbers given represent the same evolutions of heat as would be obtained by mixing 1 gm. of liquid ammonia with an $x = (x_1 + x_2)/2$ per cent. solution in such manner that x is not changed by the addition ; for example, by using a large quantity of solution. When 1 kg. of gaseous ammonia at 15° and 1 atmo. pressure is dissolved in a 60 per cent. or more concentrated solution, the heat generated is only that arising from the change of gaseous ammonia into liquid ammonia at 15° and 7·5 atmos. pressure, namely, 300 cals. The numerical results are in good agreement with the heats of solution calculated, by means of the Clausius-Clapeyron equation, from the pressure, temperature and x. T. H. P.

1132. *Regulation of Temperature in the Measurement of Osmotic Pressure.* **H. N. Morse** and **W. W. Holland.** (Amer. Chem. Journ. 41. pp. 92–117, Feb., 1909.)—An osmotic cell acts as an exceedingly sensitive thermometer, and the slightest variations of temperature suffice to produce changes of considerable magnitude in the manometer readings ; these would be of less importance if it were not that many hours elapse before the cell adjusts itself again to a proper condition of equilibrium, especially when the membrane is thick and the transference of liquid slow. It is, moreover, essential that the temperature of the liquid should be correctly adjusted, not only when the final pressure-readings are taken, but also when the final volume of the liquid is fixed by the attachment of the manometer: If the initial temperature is too low, the thermal expansion of the liquid will drive water out through the membrane and increase the concentration of the sugar in the water; conversely, a high initial temperature when attaching the manometer, will result in a dilution of the solution and a lowering of the osmotic pressure. The present paper contains a detailed account (illustrated by nine diagrams) of the thermostatic devices used to overcome these difficulties. The general scheme is on familiar lines: A large water-bath is surrounded with hair-packing and is provided (*a*) with a cold-water circulation from the mains, cooled if necessary by passing through an ice-chest, and (*b*) with a lamp-heater controlled by a mercury contact such that when the mercury expands it opens a relay and leaves a large resistance in series with the heater; the sensitiveness was such that a change of temperature of about 0·002° C. was sufficient to operate the regulator. The temperature of the air-space above the bath was controlled by circulating the air through pipes immersed in the bath, but this was supplemented finally by automatically regulating the temperature of the small room in which the bath was placed to a temperature very near to that of the bath by means of a gas stove and two small electric heaters. The ultimate results in the measurement of osmotic pressure appear to have been entirely satisfactory. T. M. L.

1133. *Electromotive Force of the Detonating-gas Cell.* **J. N. Brönsted.** (Zeitschr. Phys. Chem. 65. 1. pp. 84–92, Dec. 8, 1908. Chem. Laborat. d. Univ., Kopenhagen, Sept., 1908.)—The author has determined the e.m.f. of detonating gas by electrometric measurements of the cell H | NaOH solution | HgO.Hg. He finds the value at 17°, 1·231 ± 0·003 volts, which is in good agreement with the value calculated thermodynamically by Nernst [Abstract No. 1885 (1906)]. The measurements also allow of the calculation of the potential of the water in different alkali solutions. A. F.

1134. *Galvanic Cell producing an Alternating Current.* **W. Kistiakowsky.** (Zeitschr. Elektrochem. 15. p. 268, May 1, 1909. Elektrochem. Laborat. des Polytechnikums, St. Petersburg, March, 1909.)—Two clean iron electrodes are partially immersed in an electrolyte consisting of equal volumes of saturated bichromate solution and 2-normal sulphuric acid, and the circuit closed through a suitable voltmeter. The pointer of the voltmeter moves, at first slowly and then more rapidly, to about 0·4 volt; it then suddenly goes back to the zero-point. After about 5–10 sec. it moves in the opposite direction to −0·4 volt, to fall back again to zero, and so on. These alternations may last for hours, and the current may even be as great as 0·1–0·15 amp. These results stand in close connection with the periodic phenomena observed by Ostwald in the solution of chromium, and are being further investigated. T. S. P.

1135. *Redetermination of the Electrolytic Potentials of Silver and Thallium.* **F. J. Brislee.** (Faraday Soc., Trans. 4. pp. 159–164; Discussion, pp. 164–165, April, 1909.)—Careful measurements of the potentials of Ag and Tl electrodes in solutions of different salts of varying concentrations have been made by determining the e.m.f. of combinations of these electrodes with a tenth-normal calomel electrode. In order to calculate the electrolytic potential (E.P.), *i.e.*, the potential of a metal against a normal ionic solution of the same metal, the dissociations of the various salts have been obtained from conductivity measurements, which in the case of silver acetate were carried out by the author, but in other cases were taken from the results of other investigators. Stationary electrodes were found to give satisfactory results, and care was taken to keep oxygen from the solutions and electrode vessel, in some cases hydrogen being passed through the solution during measurement. All experiments were made at 17° C. The results obtained are as follows: E.P. for Ag, using $AgNO_3$ solutions varying in concentration from 0·002–0·5 normal, was 1·076 ± 0·00005 volts; with silver acetate solutions of concentrations 0·002–0·060 normal, the value obtained was 1·074 ± 0·0007 volts; E.P. for Tl, using $TlNO_3$ solutions of concentrations 0·002–0·1 normal, was −0·042 ± 0·001 volt; with TlCl solutions of concentrations 0·002–0·01 normal, the value found was −0·042 ± 0·0004 volt. The results obtained with TlOH as electrolyte were only approximate, since it was found that a saturated solution of ammonium nitrate, which had been used throughout the experiments for cutting out liquid potentials, was not satisfactory with basic solutions, as had previously been observed by Cumming. All the potentials given are referred to a tenth-normal calomel electrode as standard, the mercury being 0·618 volt more positive than the solution. In the *discussion* it was pointed out by **Lowry** that the mathematical method of calculating the probable errors of experiment had the fatal disadvantage that it entirely neglected the sources of error which persisted throughout a series of experiments, and were often far more serious than the mere casual variations in the readings. T. S. P.

1136. *Electrolytic Corrosion of Steel Structures.* **A. A. Knudson.** (Amer. Electrochem. Soc., Trans. 14. pp. 189–203; Discussion, pp. 203–206, 1908.)—Describes certain cases of pronounced corrosion in oil tanks constructed of riveted sheet steel plates and in other steel structures. The corrosion was found most pronounced on the floor of the oil tanks, where pittings occurred which tapered downwards and many of which terminated in holes ¾ to 1 in. in diam. The water found on the bottom of the tanks reacted alkaline. Tests were made for stray electric currents and also for thermoelectric currents without leading to a satisfactory explanation, and A. S. Cushman's view was finally accepted that the corrosion was due to local p.d. set up within the metal itself, and also that the physical condition of the surface assisted the corrosion, the slightest indentation, scratch, or cut in the surface becoming positive to the surrounding area and thus forming a nucleus for a future pit-hole. In considering corrosion of other structures, mention was made of deposits of iron and lead on pebbles as a result of electrolytic corrosion of pipes, &c., and in the *discussion* **C. F. Burgess** showed that the lead deposit was composed of white lead, and that the iron deposit was not magnetic, and so was composed of hydrate or oxide, but not of metallic iron.
C. O. B.

1137. *Formation of Nitric Oxide by Low Voltage Currents.* **G. W. Morden.** (Amer. Electrochem. Soc., Trans. 14. pp. 113–140; Discussion, pp. 140–141, 1908.)—The experiments were conducted under F. Haber at Karlsruhe. The author distinguishes between dependent current, due to ionisation at any potential, but acting only as long as the ionisation lasts; independent current due to collisions between ions and molecules and requiring a minimum electrode potential; and mixed currents. The characteristic potential-current curve shows consecutively the silent discharge, brush, glow, and arc discharges. Preliminary experiments at from 20 to 60 volts, with air pressures of from 0·1 to 8 mm. and currents of $0{\cdot}1 \times 10^{-3}$ amp., yielded merely traces of NO. Experiments at pressures of from 20 to 700 mm. were made in glass vessels containing a horizontal kathode (Ir coated with CaO, Pt, Fe) held between two nickel strips and especially heated by a current as a rule (which did not increase the yield, however); an anode of nickel, either opposite the kathode or forming a vertical air outlet tube underneath the kathode; and a conical glass nozzle for the air. The air-flow in this tube was downward through the arc. The current varied between 0·1 and 0·25 amp. at 100 or 280 volts. Full data are given. As the arcs were only from 4 to 6 mm. in length, the gases from different portions could not be separated. Higher concentrations of nitric oxide were obtained by withdrawing the gas directly from the arc, and the highest by sucking the gas through the cooled anode at air pressures of from 300 to 500 mm. Small gas velocities favour high concentrations, great velocities high yields per kw.-hour; the latter are best at high pressures. There is for every gas velocity and current intensity a maximum possible concentration; the highest concentration realised was 9·7 per cent., and the highest yield 92 mgm. per kw.-hour. H. B.

1138. *Hermaphrodite Elements.* III. **M. Le Blanc** and **D. Reichinstein.** (Zeitschr. Elektrochem. 15. pp. 261–264, May 1, 1909. Communication from the Physikal.-Chem. Inst. d. Univ., Leipzig.)—The studies which one of the authors (Le Blanc) has previously carried out with S, Se, and Te have been extended to other elements, the method of experiment being similar to that already described [see Abstract No. 1950 (1906)]. The curves giving the relation between the current density and electrode potential for iodine in *n*-H_2SO_4 showed that the potential was displaced with respect to a Pt electrode, no matter whether the iodine was kathode or anode, *i.e.*, iodine was both kathodically and anodically active. In the latter case the electrical equivalent was found to be 5, *i.e.*, the iodine goes into solution as the IO_3'-ion. In the former case the equivalent was approximately 1·5, this anomalous value possibly being due to the solvent action on the iodine of the divalent ions produced by the current. In the case of arsenic the current density-potential curves showed that anodic solution took place at practically the same potential as kathodic solution, both in *n*-KOH and *n*-H_2SO_4 electrolytes. Arsenic thus showed very marked hermaphrodite nature both with respect to hydrogen and oxygen. Attempts to determine the kathodic equivalent were not successful, but when acting as anode in 2*n*-H_2SO_4 arsenic was found to be trivalent. Antimony behaved similarly to As, but current density-potential curves could only be taken with a KOH electrolyte. The kathodic equivalent could not be determined; as anode in *n*-HCl the valency was found to be 3. Experiments with phosphorus were not successful. T. S. P.

1139. *Electro-chemistry of Solution of Gold in Potassium Cyanide.* **J. B. Ekeley** and **A. L. Tatum.** (Electrochem. Ind., N.Y. 7. pp. 156–157, April, 1909. Paper read before the West. Assoc. of Technical Chemists and Metallurgists, Boulder, Colo., Jan. 6, 1909. From the Western Chemist and Metallurgist.)—Christy showed that, in a cell consisting of two Au electrodes, one immersed in an oxygen-free KCN solution, the other in a KCN solution saturated with oxygen, Au dissolved in the oxygen-free solution, and a current flowed from this solution to that saturated with oxygen [see Abstract No. 1923 (1902)]. This is comparable with an ordinary Zn-Cu cell, the Au, on account of its solution pressure, sending Au· ions into solution, while H· ions in the oxygenated KCN vessel tend to be forced out. The latter form OH' ions with the O'' ions due to the dissolved oxygen, and these give, with the K· ions, dissociated KOH. In an Au/KCN/O-Pt couple, a current passes from Au to oxygen, and Au dissolves rapidly in the KCN, the rate varying with the concentration of the cyanide and of the oxygen in the oxygen electrode. The potential of the Au in KCN solution ranges from 0·12 volt in a 0·1 per cent. solution, to 0·29 volt in a 1·0 per cent. solution. The electro-chemical equation representing the solution of Au in the presence of oxygen is—

$$4\mathrm{Au}^{\cdot} + 8\mathrm{K}^{\cdot} + 8\mathrm{CN}' + 2\mathrm{H}^{\cdot} + 2\mathrm{OH}' + 2\mathrm{O}'' = 8\mathrm{K}^{\cdot} + 4\mathrm{Au(CN)}'_2 + 4\mathrm{OH}'.$$

The four negative charges are not necessarily carried by oxygen, but may be furnished by any other suitable substance, such as bromcyanogen, or may be produced mechanically. Bromcyanogen added to KCN solution is a very effective Au solvent, the equation being—

$$2\mathrm{Au}^{\cdot} + 3\mathrm{K}^{\cdot} + 3\mathrm{CN}' + \mathrm{Br}' + \mathrm{CN}' = 2\mathrm{K}^{\cdot} + 2\mathrm{Au(CN)}'_2 + \mathrm{K}^{\cdot} + \mathrm{Br}',$$

and it should be possible to set up a cell in which Au and solid bromcyanogen are the electrodes and KCN is the electrolyte. W. H. St.

1140. *Critical Voltages of Electrolytic Valve Cells.* **G. Schulze.** (Ann. d. Physik, 28. 4. pp. 787–807, March 16, 1909.) A continuation of the author's work on valve cells [see Abstract No. 1526 (1908)].—In the present case the experiments, with Al and Ta, are directed to the examination of the gas layer and the voltage at which sparking occurs. The results are given in Tables and reproduced oscillograms. A convenient summary is given as follows: (1) The process of formation of Al anodes can be explained on the assumption that electrolytic anions split off negative electrons when they impinge upon a high resistance and high potential gradient, and that the neutral oxygen atoms thereby produced experience, through the splitting off, a violent repulsion. (2) The growth of the gas layer during formation is occasioned by a constant flow of current distributed equally over the whole surface of the anode. That there is a critical voltage is due to the fact that the gas layer cannot keep on growing indefinitely, since at a definite voltage (the sparking potential), sparking becomes possible in the gas layer and actually occurs. The transition from the steady flow of current to the sparking condition, and the stoppage in the growth of the gas layer take place gradually from the commencement of the spark discharge onwards. (3) The sparking voltage rises with the dilution of the electrolyte, and in the case of different electrolytes, decreases, apparently, with increasing degree of dissociation (with the exception of those electrolytes which dissolve the anode or whose anions contain the metal). (4) The sparking voltage is independent of the current density during forming and of the temperature. L. H. W.

1141. *Properties of an Aluminium Anode.* **H. W. Morse and C. L. B. Shuddemagen.** (Amer. Acad., Proc. 47. No. 14. pp. 367–397, March, 1909. Contribution from the Jefferson Phys. Lab., Harvard Univ.)—The authors discuss polarisation capacity and the theory of the Al anode. Streintz had pointed out that the discharge consisted of two superposed parts, one of the nature of a condenser discharge practically complete within a fraction of a second, the other too slow for ballistic methods. The authors use several ballistic galvanometers of different periods, up to 9 seconds, and throw them into circuit by a falling weight. The anodes were formed either from a storage battery or from a dynamo; the experimental arrangements and the nature of the electrolytes are not explained. It is possible to reproduce a capacity with different samples of Al with electrodes of different areas, formed at the same voltage; other things being kept constant, the capacity is an accurate function of the formation voltage. The results of the many varied experiments are given in curves and in three-dimensional diagrams; general conclusions are not yet drawn, but it is admitted that alternating-current measurements would be more simple. A literature list is added to the paper. H. B.

1142. *Cuprous Hydroxide and Cuprous Oxide.* **H. W. Gillett.** (Journ. Phys. Chem. 13. pp. 332–335, April, 1909.)—When a solution of NaCl is electrolysed between copper electrodes, yellow cuprous hydroxide is formed at low temperatures, below 60° C., red cuprous oxide at boiling, and products of intermediate colours result at intermediate temperatures. The author attempts to precipitate the red oxide in the cold, chemically or electrolytically. It can be obtained, for instance, by precipitating cuprous chloride with very concentrated NaOH, but heating is more effective in forming the oxide; subsequent boiling of the hydrate does not produce dehydration. When the NaCl is mixed with NaOH from the first, some red oxide is obtained by the electrolysis in the cold; the yield is not quantitative, however. The author describes various experiments with or without diaphragms and with L-shaped electrodes. H. B.

1143. *Behaviour of Ethyl Ether towards the Electrical Current.* **J. Schröder.** (Ann. d. Physik, 29. 1. pp. 125–152, April 22, 1909. Extract of Dissertation, Greifswald.)—In the case of badly conducting liquids former work has shown that: (1) In most cases Ohm's law is not obeyed; (2) the conductivity alters with the time, and especially after the distillation of the liquid; (3) the conductivity alters on passage of the current; very often, after the current has been passing for some time, Ohm's law is obeyed. In the case of ethyl ether the author has investigated the matter very fully, great care being taken to clean the electrodes and also to keep extraneous matter away from the ether in the apparatus. [The ether was a pure commercial product, and does not seem to have been specially purified for the experiments, other than by distillation.] He finds that the condition of the electrodes, which were of Pt, has a very great influence on the conductivity of the ether. If they are strongly charged with gases the current increases more quickly than in accordance with Ohm's law. High potentials probably cause substances which can form ions to be expelled from the electrodes. In such cases the temperature-coefficient is always negative. If the electrodes have been heated to a white heat, a regular current saturation curve is obtained. By prolonged passage of the current in one direction the current-potential curve gradually sinks lower in the direction of current, and appears to approach asymptotically a limiting curve. With electrodes which have been heated the temperature-coefficient is positive. A portion of the ions which carry the current is produced by contact-forces between the electrodes and the liquid, which, when no current is flowing, lead to the formation of an electrical double layer. T. S. P.

1144. *Use of a Mercury Kathode in the Determination of Metals.* **A. H. Porter and F. C. Frary.** (Amer. Electrochem. Soc., Trans. 14. pp. 51–55; Discussion, pp. 55–58, 1908.)—It has recently been shown by Price [see Abstract No. 1973 (1907)] that the method of Kollock and Smith for the electrolytic determination of zinc using a mercury kathode and rotating anode gives uniformly low results, which were attributed to loss of Hg and Zn in washing the amalgam. The authors have further investigated the matter, using the particular apparatus of Frary [see Abstract No. 189 (1908)], and confirm Price's results, even when specially purified absolute alcohol and ether were used to wash the amalgam. Both Hg and Zn were found in the washings, although Hg alone does not lose weight appreciably when washed with water, alcohol, and ether. In the case of Cu satisfactory results were obtained, the amalgam being brighter and cleaner than that of Zn. T. S. P.

1145. *Determination of Zinc with the aid of the Mercury Kathode and Rotating Anode.* **L. G. Kollock and E. F. Smith.** (Amer. Electrochem. Soc., Trans. 14. pp. 59–63; Discussion, p. 64, 1908.)—The authors maintain that their method for the electrolytic estimation of zinc, using a mercury kathode and a rotating anode, gives perfectly satisfactory results. Full details are given of all the precautions which are necessary in carrying out the analysis. [These obvious precautions were observed by Price in carrying out his experiments.] The results agree very well among themselves, and also with the amount of zinc (as zinc sulphate) taken, but nothing is stated as to the method used for determining the actual amount of zinc contained in the aliquot portions (5 c.cm.) of zinc solution taken for analysis. The authors could detect neither Zn nor Hg in the washings. T. S. P.

1146. *Constant-current Electro-analysis.* **H. W. Gillett.** (Journ. Phys. Chem. 13. pp. 336–340, April, 1909.)—When two metals A and C are to be separated, whose decomposition voltages both lie below that of hydrogen, we can add a third protective metal B. Then all the A and some B will be deposited before any C is precipitated; the B is necessary to maintain the current, when the solution becomes impoverished of ions by the removal of A. It is further necessary that C does not turn passive in the solution; for C might momentarily be deposited, and should redissolve and precipitate B in that case. So far, hydrogen had practically alone been used as protective metal. The author tries copper. According to Root, the decomposition voltages in ammoniaical tartrate solution are at 60°: Ag 1·0, Pb 1·3, Cu 1·65 volts; but copper was already deposited at 1·35 volts, because the copper turned passive, and would not precipitate Ag or Pb in this solution [compare Abstract No. 1022 (1908)]. In phosphate solution the decomposition voltages at 60° C. are, according to Root: Ag 1·3, Cu 1·6, Pb 2·2, H 2·25. There the author succeeded in separating Ag and Pb (dissolved as nitrates) with copper as protective metal in well-stirred solutions (rotating anode). This is theoretically interesting, though practically the separation of Ag and Pb is simple enough, and in other cases the formation of alloys, &c., would complicate the method. H. B.

1147. *Separation of Antimony from Sulphantimoniate.* **W. Schulte.** (Metallurgie, 6. pp. 214–220, April 8, 1909. Communication from the Elektrochem. Laborat. d. Königl. techn. Hochschule, Berlin.)—The author has independently observed the precipitation of Sb from sodium sulphantimoniate solution (Schlippe's salt) by addition of Mg or Al powder, and warming to 100° C., as already noted by Czerwek. With a plate of Britannia metal (Sb 10·05, Sn 89·9, per cent.) as anode, and an iron kathode, pure Sb was obtained with a current of 285 amps. per sq. m., working at 65° to 70°. The electrolyte was sulphantimoniate solution containing 0·7826 gm. of Sb per c.cm. Similarly, Britannia metal plates were refined in sodium sulphide solution of 1·185 sp. gr. as electrolyte. Copper and iron present passed into the anode sludge. F. R.

REFERENCES.

1148. *Dependence of Melting-point upon Surface Energy of Solid Bodies.* **P. Pawlow.** (Zeitschr. Phys. Chem. 65. 1. pp. 1–35, Dec. 8, 1908.)—Experiments were made to investigate the relationship between melting-point and surface energy. The substances used were salol, antipyrine, phenacetin. For details the original paper must be consulted. F. J. B.

1149. *Gibbs's Theory of Surface-concentration, regarded as the Basis of Adsorption.* II. **W. C. M. Lewis.** (Phil. Mag. 17. pp. 466–494, April, 1909. Paper read before the Physical Soc., Nov. 27, 1908.)—[See Abstract No. 1356 (1908).]

1150. *General Theory of the Association of Similar Molecules and of the Combination of Different Molecules.* **J. J. van Laar.** (Archiv. Musée Teyler, 11. pp. 235–331, 1909.)—This paper contains a mathematical treatment of the complete theory of association, for gases and vapours and also for liquids, and does not admit of abstraction. T. H. P.

1151. *Silico-Manganese and Silico-Spiegel.* **J. Escard.** (Electricien, 37. pp. 293–297, May 8, 1909.)—Describes the preparation and properties of industrial silico-manganese and silico-spiegel and contains a detailed account of the known compounds of Si and Mn, which are: $SiMn_2$, Si_2Mn_3, SiMn, and Si_2Mn. C. O. B.

1152. *Heat Treatment of Steel.* **A. Campion.** (Iron and Steel Times, 1, pp. 157–166, May 6, 1909.)—Discusses the importance of correct thermal treatment of steels, and illustrates the points raised by means of photomicrographs and diagrams, the latter showing the relation between the drop-test results and the temperature of treatment of steels containing 0·2, 0·35, and 0·5–0·7 per cent. of carbon respectively. C. O. B.

1153. *A Theory of the Hardening of High-speed Tool Steel.* **H. C. H. Carpenter.** (Mech. Eng. 23. pp. 617–618, May 14, 1909. Paper read before the Birmingham Metallurgical Soc.)

1154. *Manganese Steel.* **W. S. Potter.** (West. Soc. Engin., Journ. 14. pp. 212–231; Discussion, pp. 231–240, April, 1909. Abstracts in Eng. Record, 59. p. 294, March 13, 1909. Mech. Eng. 23. pp. 442–444, April 9, 1909.)—Contains a considerable amount of information on the physical properties, heat treatment, and methods of rolling manganese steel. Under physical properties, gives sections on hardness, specific gravity, specific heat, heat conductivity, magnetic properties, electric conductivity, strength as affected by temperature, coefficient of friction, tensile tests and abrasive wear values. Various tests of hardness as obtained by the scleroscope are also given for a manganese steel rail, and an appendix contains the results of drop tests. C. O. B.